



PBL Netherlands Environmental  
Assessment Agency

# LINKING WATER SECURITY THREATS TO CONFLICT

An exploration of pathways

## **Background Report**

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## **LINKING WATER SECURITY THREATS TO CONFLICT; AN EXPLORATION OF PATHWAYS**

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# Summary and findings

## **Why this report?**

Water is linked to many processes and events, affecting people, economic activities and ecosystems in numerous ways. Current water stresses are increasing and projected to keep on rising, as a result of climate change, economic development, population growth and inadequate water management. The possible adverse impact of increasing water- and climate-related stress on conflict risk have recently gained the interest of a range of social, academic and political institutes. The emerging research field studying the interaction between water, climate and conflict risk is still developing and conclusions are diverse and often contested due to biases rooted in differences in approaches, methods applied, and spatial and temporal scales.

Three Dutch ministries—Infrastructure and Water management; Foreign Affairs; Economic Affairs and Climate—requested PBL Netherlands Environmental Assessment Agency to explore future water-related challenges up to 2050, including the interaction between water and conflict. Within that context, this report explores the relationship between water, climate and conflict risk, based on an extensive literature scan, encompassing over 200 publications and reports. In addition to a general exploration using Internet search engines and snowball techniques, two databases were analysed that included water-related conflict events. The Water Conflict Chronology by the Pacific Institute and the environment, conflict, and cooperation (ECC) factbook by Adelphi. The cases in these databases that were based on peer-reviewed studies and those that were not older than 30 years<sup>1</sup>, were included in this study.

To gain a better understanding of the interactions between water, climate and conflict risks, we focused on identifying:

- I. different views in the literature;
- II. various potential pathways linking water and climate to conflict risk, as found in literature. For these identified pathways, following the IPCC approach, we tried to assess the confidence level based on direct evidence and agreement in the literature.

## ***Different views in the literature on the role of water in relation to political or violent conflict***

Water has a direct link with human security. Consensus exists over the projection that water-related stresses due to natural disasters and increasing competition over water will increase towards 2050. There is substantially less consensus in the scientific literature regarding the interaction between water and political or violent conflict. Overall, findings can be roughly divided into three groups, conceptualised in Figure A. One group of studies underline the direct role of climate and water in political or violent conflicts, frequently via the narrative that resource scarcity issues are linked to conflict. Other studies underlining this view establish direct relationships using statistical methods, linking the increase in the prevalence of conflict to climatic and environmental changes, which supports the perspective of climatic change and changing water security being a major threat to global security. In line with this group of scientific studies, more policy-oriented studies present global warming and water-related issues as the 'ultimate threat multiplier' for conflict or label them as key drivers of conflict in the coming decade.

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<sup>1</sup> A few exceptions to this threshold of 30 years were made to include cases that were illustrative for the particular pathway.

A second group of studies is less explicit about the direct role of water in political or violent conflicts. At the most, these studies conclude that water is a subdominant factor, stressing the fact that a mix of determining factors are decisive, such as population density, demographic composition, governmental structures, poverty and inequality, ethnic fractionalisation, history of conflicts in the area or the presence of a neighbouring conflict.

Other studies point to the potential strategic value of water, for both cooperation and conflict. In these cases, water is an instrument rather than an underlying potential cause for conflict. These two political uses of water are not mutually exclusive; water may be an instrument for cooperation, often between riparian countries, whereas in other situations it can be used as a weapon.

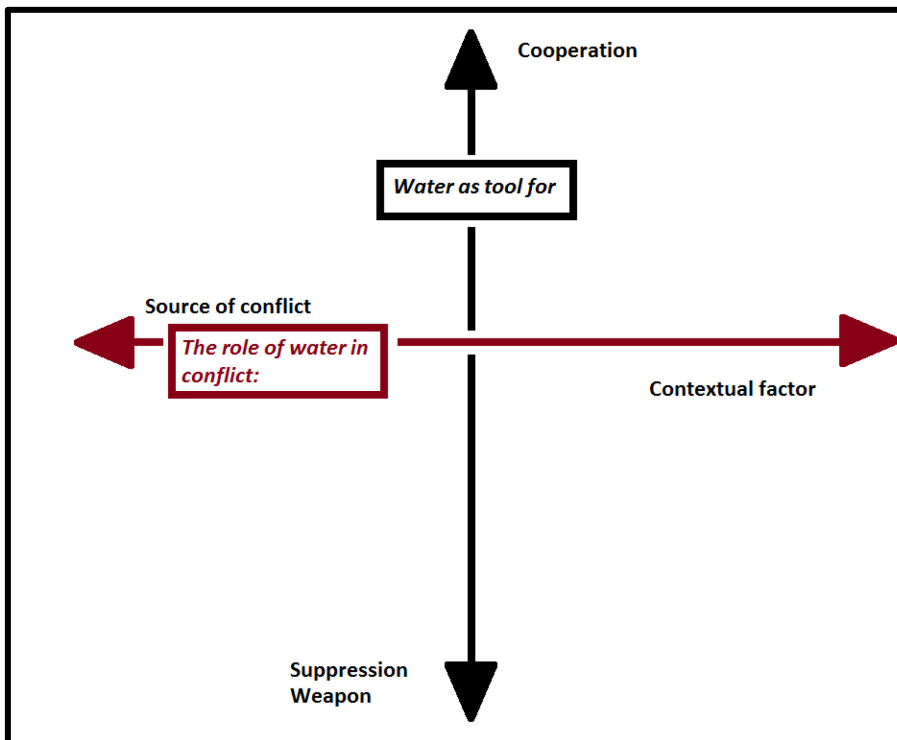


Figure A Conceptual simplification of the debate on the link between water and conflict.

Thus, we found studies ranging from alarmist reports, projecting mass migration and violent conflict due to drought and resource scarcity, holding conclusions often resonated by media, to nuanced case studies pointing to contextual factors such as conflict history, inequality and demographics as driving forces of future tension or even conflict. Overall, water-related issues, both today and for the future, are not considered to be the sole reason of conflict.

**Finding common ground: uncertainties and contextual factors**

To better understand the possible role of water in relation to conflict, 10 pathways are identified that link water to conflict, based on the literature. These pathways summarise the landscape of potential water–conflict linkages and provide common ground for analysing and discussing the underlying evidence for these linkages and the agreement in the literature. Because context is crucial, contextual factors are included per pathway, to understand under what conditions certain pathways may play out. To understand what factors increase conflict risk, in general, Chapter 3 describes conflict studies in the literature. In conflict research, definitions, timescales, frames and the use of variables differ widely, affecting conclusions and recommendations. Stability of government institutions ('effective governance'), a country's history of conflict, neighbouring conflict, resource curse, economic conditions, level of education and demographics are all factors that may play a role in the development of

conflict. Especially governance aspects and economic inequality have been observed to play a role in conflicts related to water issues.

To assess the level of confidence per pathway, we followed the IPCC approach, by defining the evidence and level of agreement, for a specific pathway. This was done in a semi-quantitative way, based on the number of peer-reviewed case studies in combination with the nature of the evidence, and on the percentage of peer-reviewed studies that draw similar conclusions.

### **Ten pathways linking water to conflict risk**

Table A summarises the 10 pathways discussed in this report. Dozens of case studies were found to discuss these linkages, although their conclusions and methods differ widely. The pathway explaining the use of water as a weapon during conflict is the only pathway that is rather undisputed. This is probably because this link does not propose a causal role to water in conflict but shows the instrumental value of water during conflict. Three pathways—on local water stress, food price spikes and the construction of dams—were found to have robust evidence, over 10 case studies per link. However, the case studies supporting these pathways do not always arrive at the same conclusions, and, for all three pathways, the actual context, mainly governance- and inequality-related, are decisive. The pathway that discusses possible geopolitical tensions because of Arctic melt differs from the other linkages in several ways. Melting sea ice could lead to tension because fossil fuels and minerals may become accessible, but cooperation because of new shipping routes could also be a possibility. Thereby does this pathway only consider one case, rather than multiple cases on different locations. For this pathway, the number of peer-reviewed studies on possible geopolitical tension due to a melting Arctic were analysed, providing a robust level of evidence.

Four of the identified pathways—rainfall variability, fertile land scarcity, migration and displacement, and economic shocks—are supported by 5 to 10 peer-reviewed case studies. These different pathways are frequently mentioned in overview studies and conceptual studies, although there are not many contemporary peer-reviewed case studies in support of these pathways. The final pathway—concerning the use of water as strategic target—discusses whether water reservoirs could be strategic military target for nation states or terrorist groups in water scarce regions. Only two well-documented cases have been found: that of Tibet and the Golan Heights. This pathway was included nevertheless, to underline that historical events provide little evidence for regional wars being fought over water reservoirs.

*Table A Ten identified pathways potentially linking water to conflict and corresponding confidence levels (based on evidence and agreement in the literature), context and scale (local, regional, transboundary, international).*

<b>Pathway</b>	<b>Confidence</b>	<b>Context</b>	<b>Scale</b>
Water as weapon or strategic tool/measure can be used in situations of conflict, possibly intensified by water stress	Robust evidence High agreement	Existing conflict, food/water scarcity High vulnerability of vital infrastructure	Local–regional
Local water stress (droughts, economic scarcity, inaccessibility) may induce or intensify conflict over remaining water and food in fragile contexts	Robust evidence Medium agreement	Economically and politically deprived populations High dependence on rainfall Environmental mismanagement Existing tension/grievances between communities	Local
Food price spikes as a result of water-related disasters may accelerate or instigate	Robust evidence Medium agreement	Economically deprived populations, high percentage of income spend on food	Local – global relations

local/regional riots increasing conflict risk		Misuse of power by elite factions Existing grievances against elites or the state Political instability	
The construction of mega dams may lead to tension between countries in a context of power struggles and shortages due to overexploitation	Robust evidence Medium agreement	Existing grievances and distrust between countries Rapidly developing projects Rapid political changes Little institutional capacity	Transboundary
A melting Arctic may change regional geopolitical relations and cause tension or conflict between countries	Robust evidence Medium agreement	Existing grievances and distrust between countries Conflicting national interests Little communication and openness	International
Variability in rainfall may influence the outbreak of local conflict and type of conflict in regions dependent on rainfall—increasing variability may lead to increasing levels of societal disruption	Medium evidence Low agreement	Direct dependence on rainfall for agriculture and cattle raiding Existing historical tension over land and water rights	Local–regional
A shortage of fertile land Resulting from land degradation & water stress (droughts, economic scarcity and inaccessibility) may induce local conflicts over the remaining fertile land, not necessarily at the same time or location	Medium evidence Low agreement	Deprived populations High dependence on rainfall Absent or unequal land policies - Misuse of power by elite factions Existing tension between communities or international investors Incoming migration and population pressure	Local–regional
Migration and forced displacement May increase as a result of water-related disasters, possibly causing tension or even conflict in receiving areas	Medium evidence Low agreement	Demographic composition of originating and receiving areas Economically and politically deprived populations, food insecurity Existing conflict in receiving and/or originating areas Networks Political freedom	Local–international
Economic shocks as a result of natural disasters can increase inequality adding to social disruption and grievances, increasing conflict risks	Medium evidence Low agreement	Low adaptive capacity, current grievances, unfair distribution of aid (increasing grievances), poverty trap	Local–regional
Water resources or water reservoirs can be pursued by nations or terrorist/rebel groups Under conditions of water stress	Limited evidence Medium agreement	Existing tension between nations, suppression, (perceived) water stress, history of conflict	International

## **Conclusion**

As shown in our analysis, water can be linked to conflict directly or indirectly in different ways and on different scales. In this report, an extensive literature study was carried out and 10 linkages were analysed in-depth, supported by case studies, to improve understanding of the current debate and the state of research and the possible linkages between water,

climate and conflict. The ongoing debate and differing views can be understood as a result of the current stage of research. The analysis of climate, water and conflict is an emerging field of research, and following the notion of Thomas Kuhn, in the stage of immature science. This notion presents an important juncture for theoretical development, developing a common language for scientists working on this topic.

Overcoming the different views and leaving out the rather undisputed water-as-a-weapon situations, the processes observed in the water and conflict linkages can be generalised, especially when water is considered as an indirect, contextual cause of conflict. Building on our analysis we find that water-related conflict risk is especially characterised by the:

- absence of stable institutions and an effective government, often conceptualised by good governance;
- deepening of poverty, lowering thresholds for individuals to engage in developing unrest/insurgency, since there is less to lose;
- deepening of inequalities between both people and nations, fuelling feelings of grievances;
- acceleration of changing power relations on all geographical scales as a result of increased inequalities;
- unequal distribution of remaining resources or aid resources—which may lead to increasing competition under conditions of scarcity or grievances.

Assuming that these factors are indeed of importance in the linkage between water and conflict, we conclude that the above four factors explicitly should be considered in developing adequate strategies reducing (future) conflict risk in the context of water and climate.

#### **Final remark: Dealing with complexity; reducing future risks and improve understanding**

Most of the research used for this study is based on historical data and case studies. It is not clear to what extent these historical precedents may inform us about the future interaction between water and conflict. In a business-as-usual scenario though, the growing population in developing countries and economic development will in combination with the projected climate change substantially increase water stress, especially in already vulnerable regions (e.g. PBL 2018). It seems a sensible step therefore, to explicitly account for the potential effects of climate change and future competition over water in today's development policies on river basin, national and local scale. The complexity of the climate-water-conflict interaction, at the same time, requires policy development processes integrating economic, social, security and climate knowledge and addressing the four factors identified above, affecting water and conflict risks. Since the local social and cultural context is found to be a crucial factor, participation of local communities in policy development will be of importance for reducing security and conflict risk. Investing in good governance, a factor that has been mentioned in multiply terms in many case studies and overview studies, is a crucial factor in reducing risks and building a safe environment.

Also, in the scientific domain, transdisciplinary research will be required to improve the understanding of the complex interactions between water, climate and conflict, in the context of development. Building knowledge deriving from domain-crossing research, monitoring and evaluating processes of developments in the field, and bringing together knowledge and experiences from different scales and places may contribute to a better understanding, accelerate learning processes and may fuel the development of promising strategies and measures to reduce future tensions and conflicts.



# 1 Setting the scene

Water plays a critical role in social and economic progress at global, regional, national and local levels. Sufficient and clean water is a condition for development, and water-related projects are often stimulating cooperation, between countries, communities or individuals (Brochmann and Gleditsch, 2012; Whittington, Wu, and Sadoff, 2005; Wolf, 2007). Global climate change will influence water security through changes in storm intensity, sea level rise, and precipitation patterns resulting in drought, flooding, and changing groundwater recharges. The changing impacts due to climate change are related to weather extremes and to slow-onset changes in temperature and water availability. Thereby can unsustainable water use and the construction of water resources infrastructure (especially dams) cause water insecurities. There is little dispute with regard to the direct link between water and human security, and there is a high level of consensus on the significant increase in the impacts of water-related disasters and competition for water. Reducing the impacts of weather-related hazardous events is a major aim of climate adaptation and disaster risk reduction policies, which are supported on a global scale by the Sustainable Development Goals (SDGs) and Sendai Framework for Disaster Risk Reduction.

The combination of projected population growth, economic development and climate change may increase water-related risks for sustainable livelihoods, and in exceptional cases these developments may affect political stability (Gleick, 2014; von Uexkull, 2014). There is, however, substantially less consensus in scientific literature regarding the interaction between water and political or violent conflict. Over the last 15 years, political, scientific and social institutes have increasingly studied possible relations between water and political stability, nonetheless, these relations are academically contested (Adger et al., 2014). This report analyses over 200 studies that have assessed the link between climate, water and conflict. The debate is scattered, as a result of different research designs, use of variables, definition of concepts and problem framing. Overview studies have summarised different findings, but a clear, thorough overview that informs the debate on the level of agreement and evidence is missing.

## 1.1 Aim of the Report: Better understanding water and conflict relations

Contemporary research towards perceived climate, water and conflict relations often refers to the importance of better specifying under what social, economic, political and cultural conditions specific mechanisms may play out (Buhaug, 2016; Seter, 2016; Wischnath and Buhaug, 2014). Since water-related issues are not expected to become sole causes of conflict, it is important to analyse the indirect effects via adverse economic and livelihood impacts (Buhaug, 2016). The need for a better understanding regarding these context variables, specific mechanisms and the level of consensus, is the starting point of this study, together with the notion that water and conflict links are contested up till today. The research questions guiding this study are therefore defined as:

- 1) How can we understand the often-contested outcomes of studies on the interactions between water, climate and conflict?
- 2) What pathways can be distinguished linking water insecurities to conflict, and what is the contemporary level of evidence and agreement towards this specific pathway?

Acknowledging the existence of different research frames, political interests and divergent future projections, the main goals of the study are to:

- provide insight in the possible differences in the appreciation of the role of water and climate in conflict risks in literature;
- identify the main context variables posing risk to the development of conflict to understand which of these variables also play a role in possible water-related conflict pathways;
- identify and understand the main pathways linking water security threats to conflict risk;
- understand the degree of uncertainty by defining the level of scientific evidence and agreement per pathway.

The aim of the report is to identify and understand water and conflict relations, rather than giving policy recommendations. To give policy recommendations, a second study towards mitigating factors and the pacifying effects of water cooperation must be performed, to understand what policies may be effective. This does not fall under the scope of this study.

## 1.2 International context and missing links

This study fits within the emerging international research performed by global institutes, think tanks and universities towards the possible impacts climate change may have on societies and geopolitical relations. The increasing attention from governments, non-governmental organisations (NGOs) and global organisations is relatively new and developed the subject over the past 15 years from a niche to a mainstream topic. However, the notion that environmental conditions and climate change influence and shape societies is not new. The influential Brundtland report *Our Common Future* (1987) already pointed towards future environmental stress as both a driver of and result of violent conflict. According to this report is Environmental stress projected to have a major role in security and migration developments, but seldom in isolation. Poverty, and social injustice are identified as main risk factors.

Several international resolutions, including the European Security Strategy (2009) and the United Nations (UN) via among other bodies the High Level Panel on Threats (2004), have addressed potential links between a changing climate and conflict. Although the UN published several country-specific reports on this topic, until now the Intergovernmental Panel on Climate Change (IPCC) did not cover the matter uncluttered. The possibility that climate change influences conflict risk was mentioned by the IPCC for the first time in 2001 in the Third Assessment Report, although the message was scattered throughout the report. In addition, the Fourth Assessment Report contained some information about possible relations between climate change and conflict. The Fifth Assessment Report by Working Group II contains a more careful assessment of the climate change conflict nexus especially in the *Human Security* chapter (Adger et al., 2014). But the overall IPCC message in the fifth Assessment report has been criticised since the four chapters touching on the climate-conflict nexus do not all state the same conclusions (Gleditsch and Nordås, 2014). In a special IPCC report (2012) on risks related to extreme events and disasters, attention is given to the climate change and conflict relation. In this special report climate change is regarded as a risk multiplier for instability in the most volatile regions in the world.

The World Bank has been reporting continuously on the possible relations between climate change and conflict, mostly with a focus on water. Dozens of reports have been published in recent years, often with a direct link to poverty and migration. Their main message is that climate change may intensify or may even be a (sub) cause of conflict in regions already vulnerable to climate change related hazards, with a mayor role for water-related issues (Hallegatte et al., 2016; Hallegatte, Vogt-Schilb, Bangalore, and Rozenberg, 2017; Clionadh Raleigh, Jordan, and Salehyan, 2008; World Bank Group, 2016). A central recommendation

in their studies is often to foster economic development for all and to open national and regional markets for global trade, thus enabling poor people to escape poverty and decreasing conflict risk. The World Economic Forum (2016) underlines this analysis, pointing to, among other things, extreme weather events, the global water crisis and large-scale involuntary migration as main risks for economic development and stability.

The SDGs, drafted by the United Nations, cover certain topics discussed in the pathways in this report: SDG 1 No Poverty; SDG 6; Clean Water and Sanitation; SDG 13 Climate Action; and SDG 16; Peace, Justice and Strong Institutions. However, no further analysis of how these goals interact have been made, and how failure of specific water-related developments may affect SDG 16. Recently, a study commissioned by the G8—The New Climate for Peace report by Rüttinger et al. (2015)—provides a broad overview of past and current conflicts linked to environmental change. This study frames climate change as the ultimate threat multiplier for conflict; a discourse which is often contested in academic literature (Benjaminsen, 2008; De Châtel, 2014; Selby and Tadros, 2016). And although this overview provides valuable summaries of past and contemporary conflicts, it lacks a description of general mechanisms.

In most, if not all, studies and reports on this topic, a more general, content-focused summary of the most important climate, water and conflict mechanisms is lacking. Studies either focus on case studies, large N-statistical studies or a review of the literature. This study aims to connect case studies with larger reviews or statistical studies by qualitatively analysing the mechanisms found in the literature. This is done to improve contemporary theoretical understanding.

### 1.3 Report outline

To answer the main research questions, this report is structured as follows. Chapter two will define the main concepts used in this report and explain the methodology used for this study. Chapter three discusses main conflict drivers identified by different conflict scholars, to understand what variables may pose a threat to water-related conflict. Chapter 4 discusses different frames and views that can be identified studying climate, water and conflict links. Chapter 5 presents the 10 pathways linking climate, water and conflict, including numerous case studies and the level of agreement and evidence per specific link. Chapter 6 reflects on the results given, discussing missing aspects, uncertainties as well as the implications and importance of the findings. Chapter seven gives an overall conclusion.

# 2 Conceptual Approach and methodology

Conflicts clearly pose a threat to human security, but in reverse can the lack of human security be the cause of conflicts. Water security constitutes a crucial element of human security and may therefore be connected to conflicts. This chapter consists of a description of used key terms, conceptual framework and methodology followed to identify and value possible connections between lacking water security and conflicts.

## 2.1 Defining the central concepts

### **Water security**

This report departs from the notion that the environmental, people and political sphere are interlinked and continuously redefining each other. Therefore, these domains should be analysed in an integrated way, qualitatively and quantitatively when water security and conflict relations are discussed. Climate change, economic development and demographics impact the three domains in relation to water security. Water security is the central concept in this study, meaning a safe and stable 'water climate', defined by UN Water (2013) as:

*The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.*

The concept of water security thus covers the environmental, human and political aspects of water. There are quite a number of water stress or water scarcity indicators to quantify the water security in terms of availability, all with slightly different features covering more or less aspects (Rijsberman, 2006). Most - if not all - of these indicators value scarcity in an absolute sense, where water stress or water security is to a large extent determined by changes in known patterns. Water security is in a way relative, people in dry areas are used to extreme dry conditions compared to people living in the tropics. They have several adaptation options to their disposal to cope with it, but water security might really be threatened if the frequency or the severity of these extreme events increase.

### **Human security**

Water security is a condition for human security. Human security is determined by the access to clean and sufficient water, food, energy, income and equality, health and sanitation facilities, and protection against water-borne pollution and water related disasters (Adger et al., 2014). The concept of human security has many definitions. This report follows the broad definition used by the IPCC in the Fifth Assessment report (Adger, Pulhin et al., 2014 p. 758):

*A condition that exists when the vital core of human lives is protected, and when people have the freedom and capacity to live with dignity.*

In this study, the focus will be on those aspects of human security that can directly be linked to changes in climate conditions and resources, notably health and sanitation, food, water and energy security, security of income, social and economic equality. Aspects like gender equality are not discussed in this report, although this is an aspect of human security.

## Conflict status, peacefulness

The concept of conflict is not clearly and uniformly defined within conflict research. Diverse research articles and research institutes define conflict in a different way. These heterogeneous definitions do not only result in methodological difficulties, but also in differences in how peaceful countries are ranked. Annex 2 shows the level of conflict/peace according to the Global Peace Index, the Conflict Barometer and the Fragile States Index.

Beside the ranking of peacefulness, do some scholars define three levels of conflict: no conflict, minor conflict and major conflict (Hegre, Karlsen, Nygård, Strand, and Urdal, 2011) or peace, one-sided conflict and two-sided conflict (Besley and Persson, 2011) where others define only two levels: conflict or no conflict (Goldstone et al., 2010). To include small scale, local conflict and international conflict in the analysis of this report, a conceptual definition is followed. The definition comes from the Conflict Barometer 2015 (2016), published by the Heidelberg Institute for International Conflict Research (HIIK) and is applicable to both local and interstate conflict, violent and non-violent. HIIK defines conflict as:

*A perceived incompatibility of intentions between individuals of social groups. Such an incompatibility emerges from the presences of actors who communicate and act regarding certain objects. These actions and communications are known as measures, while the objects form the issues of positional differences. Actors, measures, and issues are the constitutive attributes of political conflict.*

Conflict actors can be individuals or collectives, including countries, international organisations and non-state actors. Conflict measures are thus actions or communications by conflict actors, where conflict issues are material or immaterial goods pursued by conflict actors via conflict measures. The definition is adopted illustratively because the absolute numbers of casualties, refugees, personnel, weapons, and destruction assigned to a specific type of conflict are not included in this report. Conflict has different levels of intensity. The HIIK defines five levels of conflict, adapted for this report and conceptually displayed in Figure 2.2, showing a qualitative description of the intensity level. The different levels are pointed out to emphasise that the definition of conflict is not limited to armed, violent conflicts in this report.

### THE CONCEPT OF CONFLICT INTENSITY

terminology	level of violence	
dispute	non-violent conflicts	Social disruption, political tension, competition
non-violent crisis		Social disruption, political tension, competition, migration
violent crisis	violent conflicts	Violent events and competition, migration
limited war		Violent destruction of livelihoods, large scale migration
war		Destruction of society, mass migration

Figure 2.1 Different levels of conflict intensity. Adapted from HIIK (2016).

## The Global Peace Index

For the statistical analyses by Visser et al. (2018)<sup>2</sup>, used in this study, the Global Peace Index (GPI) has been used. This index has been used because countries are scaled on their level of peacefulness in this index, apart from a specific definition of conflict. The GPI is based on 23 indicators in three overarching categories: ongoing domestic and international violence; societal safety and security and militarisation.

<sup>2</sup> This forthcoming background study is performed within the same overarching project as this report results from. The report assesses correlations between the Global Peace Index and numerous other variables, including governance, GDP, food security, employment, on a country scale.

## 2.2 Composing the pathways

The different links between water and conflict were conceptualised as pathways, which were subsequently composed in a qualitative way. An in-depth literature study focusing on case studies, clearly marks different narratives on different scales. In addition to a general search using Internet search engines and snowball techniques, two databases were analysed that include water-related conflict events: the Water Conflict Chronology by the Pacific Institute and the environment, conflict, and cooperation (ECC) factbook by Adelphi. The cases in these databases that were based on peer-reviewed studies and were not older than 30 years<sup>3</sup> were included in this report. The identified narratives were discussed thoroughly, and subsequently clustered in pathways. These narratives overlapped, in some cases. Local conflicts related to land, for example, are often also related to the availability or lack of water elsewhere. Still, the emphasis of specific case studies is mostly focused on either water or land. For this report, over 200 studies were assessed, ranging from specific case studies to larger overview articles.

## 2.3 An evidence–agreement approach

Studies on the water and conflict nexus vary widely. As mentioned in the introduction, links are contested and perspectives differ. But these discussions differ per relation; some pathways are less contested than others. Some overview studies address different climate, water and conflict links and the lack of consensus within the research field, but these studies do not give systematic overviews of linkages and their level of consensus (Ide and Scheffran, 2014; Salehyan, 2014; O.M. Theisen, Gleditsch, and Buhaug, 2013). A study by Scheffran et al. (2012), comparing long-term quantitative studies concerning climate-related indicators and data on violent conflict using large-n designs, does provide a more quantitative overview of . Although this paper shows that most of the studies assessed find some sort of link, the analysis of the large-n studies does not provide insight in the complexity of the pathways, neither does it discuss case studies.

The deficiency of a clear, in-depth and comprehensive overview regarding the level of uncertainty per link provides an important reason to make this assessment. To value the level of consensus per pathway, the method based on the evaluation process of the IPCC to define the level of confidence is indicatively used. The level of confidence is based on the level of academic agreement and the amount of academic evidence. Figure 2.3 displays the scale of confidence as defined by the IPCC.

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<sup>3</sup> Minor exceptions to this threshold of 30 years were made to include cases that were illustrating to the pathway.

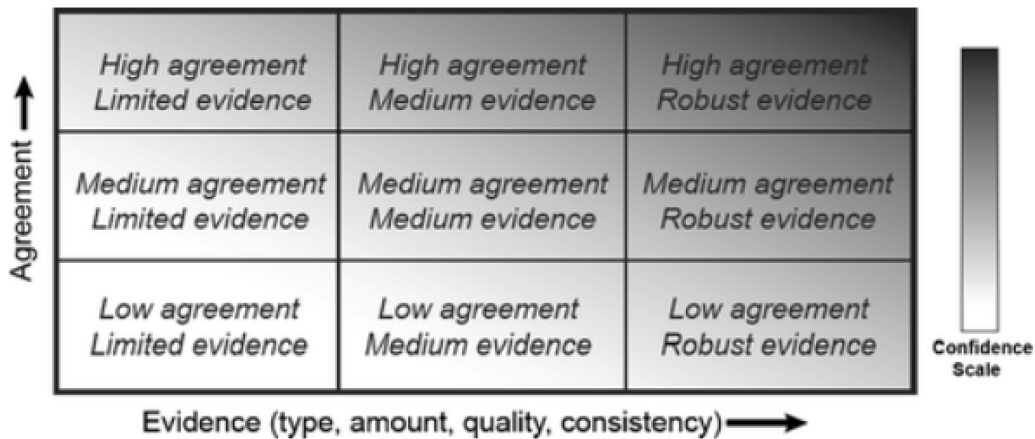


Figure 2.2 Depiction of evidence and agreement levels as used by the IPCC (taken from Mastrandrea et al. 2011)

For each specific pathway, this has been done in the following way:

*Evidence:*

- Robust evidence: over 10 peer-reviewed case studies discussing the specific link.
- Medium evidence: between 5 and 10 peer-reviewed cases describing the case.
- Limited evidence: less than 5 peer-reviewed case studies.

*Agreement:*

- High agreement: almost all peer-reviewed case studies have, given the difference in use of variables, the same conclusion
- Medium: Over half of the peer-reviewed case studies have the same conclusion
- Low agreement: Less than half of the peer-reviewed case studies have the same conclusion

# 3 Conflict: definitions, risks and contestation

Before the report turns to the specific pathways, drivers of conflict are discussed. Why does tension between communities or countries start and how do these intensify into violent conflict? To better understand the possible role of water-related events in conflict situations, six often cited but diverse studies assessing conflict variables are discussed.

## ***Divergent definitions of conflict, divergent explanations for conflict***

The studies, summarised in Table 3.1, do not define conflict or war in the same way, neither do these studies make use of the same model characteristics. This makes it impossible to quantitatively compare their conclusions in this report. The variables used in the models and studies are defined differently. Two out of six studies are forecasting models giving future conflict projections based on historical data, while the other four studies analyse main explanatory variables. Still, it is valuable to analyse the conclusions of these studies, to see which situations would carry the risk of conflict, in general.

### 3.1 Six studies assessing causes of conflict

Overall, all studies emphasise the role of governmental institutions and the quality of livelihoods expressed in economic and social variables, such as poverty and demographics, although the studies do not agree on major variables. The studies do agree on the observation that civil wars are disproportionately concentrated in poor parts of the world where inequality is high (Besley and Persson, 2011). The article by Hegre et al. (2013) is the only study predicting armed conflict on the long term, towards 2050. One of the main conclusions of this study is that the global number of conflicts, on average decreasing since the cold war, will continue to diminish to half the rate of 2012 in 2050. This is partly because of a loop caused by a continuing diminishment of conflicts in neighbouring countries. This study does not take variables into account that cannot be adequately forecasted, such as economic developments and political institutions that are central in the other studies.

The main driver of conflict and insurgency, according to both leading studies by Collier and Hoeffler (2004) and Fearon and Laitin (2003), is the absence of economic opportunities for deprived populations, which may lead to insurgency, like people joining rebellion organisations. Collier and Hoeffler focus on an economic calculus of costs and opportunities for the control over commodities, with an additional effect from fear of domination by ethnic majorities or grievances resulting from former conflicts. Fearon and Laitin conclude that more ethnically diverse countries are not more likely to experience civil war. Both studies focus on resources, in terms of abundance and scarcity, as driver of conflict.

Goldstone et al. (2010) and Besley and Persson (2010) emphasise that the role of state institutions is more important for the development of conflict than economic incentives are. A united and competent regime can handle potential insurgents or shocks like natural disasters, while weakened and paralysed regimes cannot handle insurgencies, possibly leading to civil war or oppression. Within these studies, the access to resources is indirectly part of the analyses. The study of Besley and Persson emphasises that shocks on wage rates are directly related to the occurrence of civil conflict, influenced by environmental factors. Within the model of Goldstone et al. (2010), child mortality is used as a proxy for the availability of sufficient food and water, health care and sanitation. However, the availability of, and access to resources and the impacts of shocks on societies are at least partly



dependent on policies and the capabilities of institutions. Bara (2014) shows in her study that the combination of incentives *and* opportunities is required for conflict because a group/country should be both willing and able to rebel or resist.

Table 3.1 Major causes for conflict according to six conflict studies

<i>Authors/Institute</i>	<i>Summary</i>	<i>Main (explaining) variables</i>
<i>Goldstone et al. (2010) A Global Model for Forecasting Political Instability</i>	This model distinguishes countries that experienced <b>intrastate</b> instability from countries that did not, built on onsets of political instability based on events from 1955–2003. The model uses few variables, of which political institutions is regarded as the most dominant one by far.	<ul style="list-style-type: none"> <li>- Instable political institutions</li> <li>- High infant mortality</li> <li>- Conflict in neighbouring countries</li> <li>- Political/economic discrimination</li> </ul>
<i>Hegre et al. (2011) Predicting Armed Conflict 2010–2050</i>	This model predicts <b>global and regional</b> armed conflicts for the 2010–2050 period based on data from 1970 to 2009. Predictions are made for no conflict, minor conflict and major conflict.	<ul style="list-style-type: none"> <li>- Population size</li> <li>- Infant mortality rate</li> <li>- Demographic composition</li> <li>- Education levels</li> <li>- Oil dependence</li> <li>- Ethnic cleavages</li> <li>- Neighbouring characteristics</li> </ul>
<i>Fearon and Laitin (2003) Ethnicity, Insurgency, and Civil War</i>	This study searches for the causes of <b>intrastate</b> conflict by using data from 1945 to 1999. The authors reject a focus on ethnic or religious characteristics as a root cause for conflict. Factors that favour insurgency explain increased risk on conflict. This study includes colonial wars where others do not.	<ul style="list-style-type: none"> <li>- Poverty, slow economic growth</li> <li>- Political instability</li> <li>- Rough terrain</li> <li>- Large populations</li> </ul>
<i>Besley and Persson (2011) The Logic of Political Violence</i>	This study analyses whether <b>intrastate</b> political violence emerges in the form of repression or civil war and which economic and political factors drive one-sided (repression) or two-sided (civil war) violence.	<ul style="list-style-type: none"> <li>- Political institutions, policies</li> <li>- Shocks affecting individual incomes &amp; aid and the timing of shocks</li> </ul>
<i>Collier and Hoeffler (2004) Greed and grievance in civil war</i>	Analyses of causes of civil war in the period 1960-1999. Grievances and opportunities are being approached as main incentives for war, although proxies for these factors are hard to find.	<p>Grievances:</p> <ul style="list-style-type: none"> <li>- High inequality</li> <li>- A lack of political rights</li> <li>- Ethnic and religious division</li> </ul> <p>Opportunity:</p> <ul style="list-style-type: none"> <li>- Capture of resources</li> <li>- Gaining power</li> </ul>
<i>Bara (2014) Incentives and opportunities: A complexity oriented explanation of violent ethnic conflict</i>	This study uses the method of qualitative comparative analyses from 1990-2009. The study shows that the discussion concerning whether conflict is opportunity driven or incentive driven is a false one. Both incentives and opportunities must be present to drive a conflict.	<ul style="list-style-type: none"> <li>- Conflict Trap</li> <li>- Bad Neighbourhood</li> <li>- Ousted Rulers</li> <li>- Resource curse</li> </ul>

None of the studies explicitly mentioned the possible impacts of water-related events on conflict, although the more resource orientated studies of Collier and Hoeffler (2004) and Fearon and Laitin (2003) may take the effects of changing water availability into account in a next study because economic incentives are likely to change. The findings by Besley and Persson (2011) may be directly linked to climate change and related-water events. This

modelling study finds that a combination of shocks, in terms of natural disasters - received from the EM-DAT database - and weak institutions are causes for political conflict. Although this study does not refer to climate change itself, it is not hard to imagine that when the number of natural disasters increases, conflict risk increases as well when conditions stay the same.

### **Main conflict risk variables**

Debate will continue to exist regarding main drivers of conflict. But several variables are found in the studies summarised in Table 3.1. These variables are found in a greater or lesser extend in most contemporary conflicts:

- (in)Stability of government institution ('effective governance').<sup>4</sup>
- Conflict trap: a combination of a countries history of conflict, neighbouring conflict and resource curse.
- The economic conditions of a country: economic/ethnic inequality, poverty, income shocks (simplified to GDP per capita).
- Demographics, youth bulges (defined based on the number of inhabitants younger than 14 years)
- Level of education (number of years educated per capita). This variable is closely related to governance, since 'good' governance results in better education. Therefore, this variable was not further considered.

These findings are subscribed by the findings by Visser (2018)<sup>5</sup>, analysing the relation between inequality, governance<sup>6</sup> and GDP per capita with the GPI 2016 (Figures 3.1 and 3.2). A clear correlation between the peacefulness of a country on the one hand, and governance is found. A correlation between economic inequality and GDP and the GPI, however, is less clear.

#### **Box 1. Governance**

Governance has been defined in many ways. In this report, the definition by the World Governance Indicators (WGI) of governance is followed, which is focused on countries:

*Governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. (Kaufman and Kraay, 2015).*

<sup>4</sup> For this study the indicator 'governance effectiveness' from the worldwide governance indicators (Kaufman and Kraay 2015) has been combined with the final indicator from the corruption perception index (Transparency International, 2017).

<sup>5</sup> This study is also performed in the context of the publication *The geography of future water challenges* (2018) executed from January 2017 until March 2018 lead by the PBL Netherlands Environmental Assessment Agency. The project was commissioned by the Interdepartmental Water Cluster, made up by the ministry of Foreign Affairs, the ministry of Infrastructure and Water and the ministry of Economic Affairs.

<sup>6</sup> The composite governance indicator is made up by the World Banks 'government effectiveness' indicator (Kaufman and Kraay 2015) and the composite indicator from the corruption perceptions index ([https://www.transparency.org/news/feature/corruption\\_perceptions\\_index\\_2016](https://www.transparency.org/news/feature/corruption_perceptions_index_2016)).

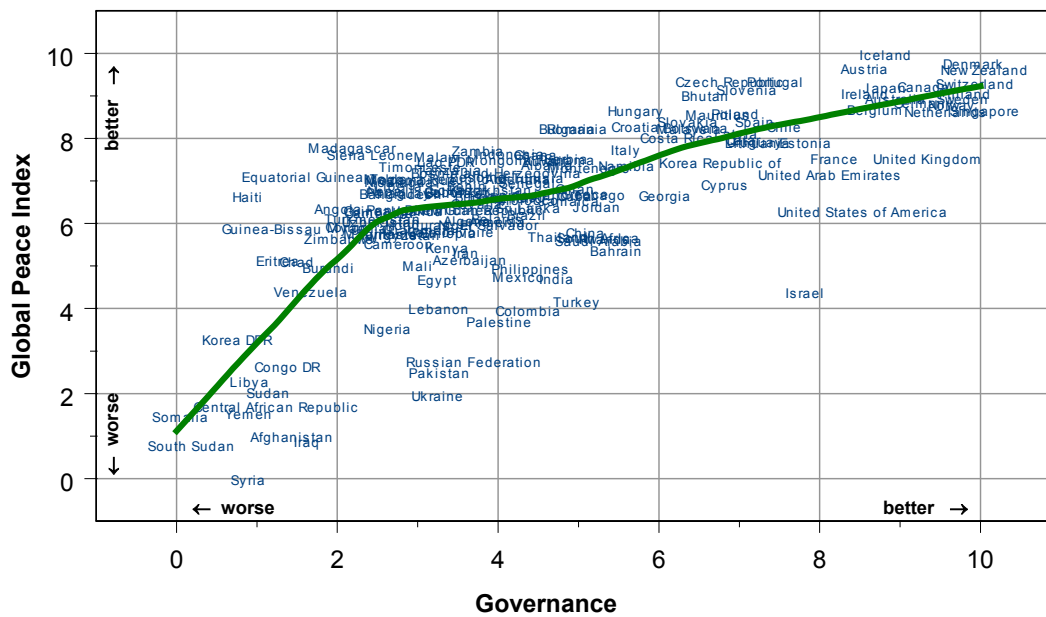
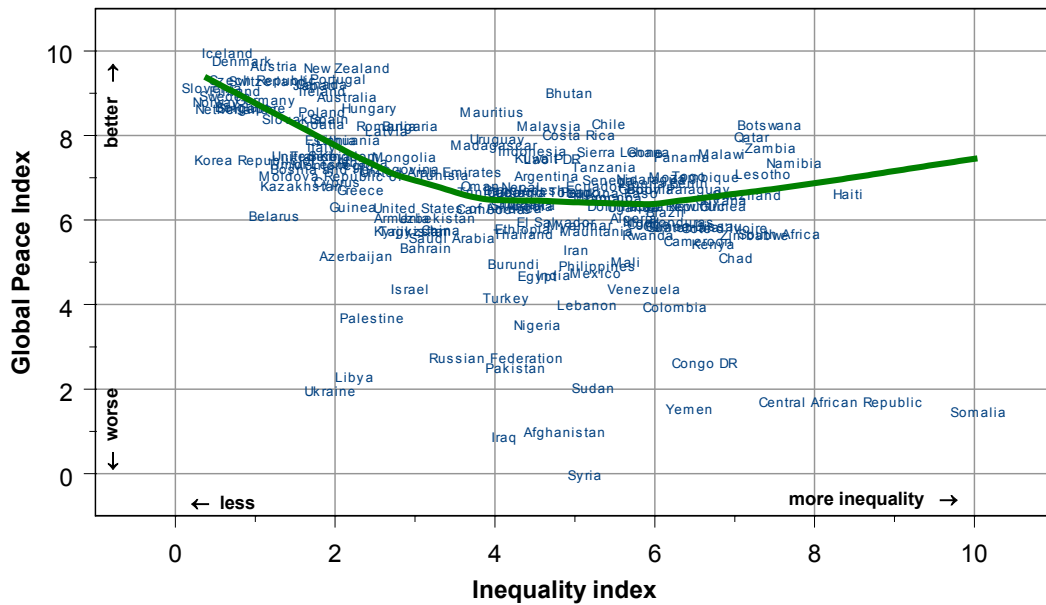


Figure 3.1 Scatterplots giving the relation between the Global Peace Index and Inequality (upper panel) and the Global Peace Index and Governance (lower panel). The trends (green lines) are estimated by a LOESS routine. Data hold for the year 2016 and for 157 countries.

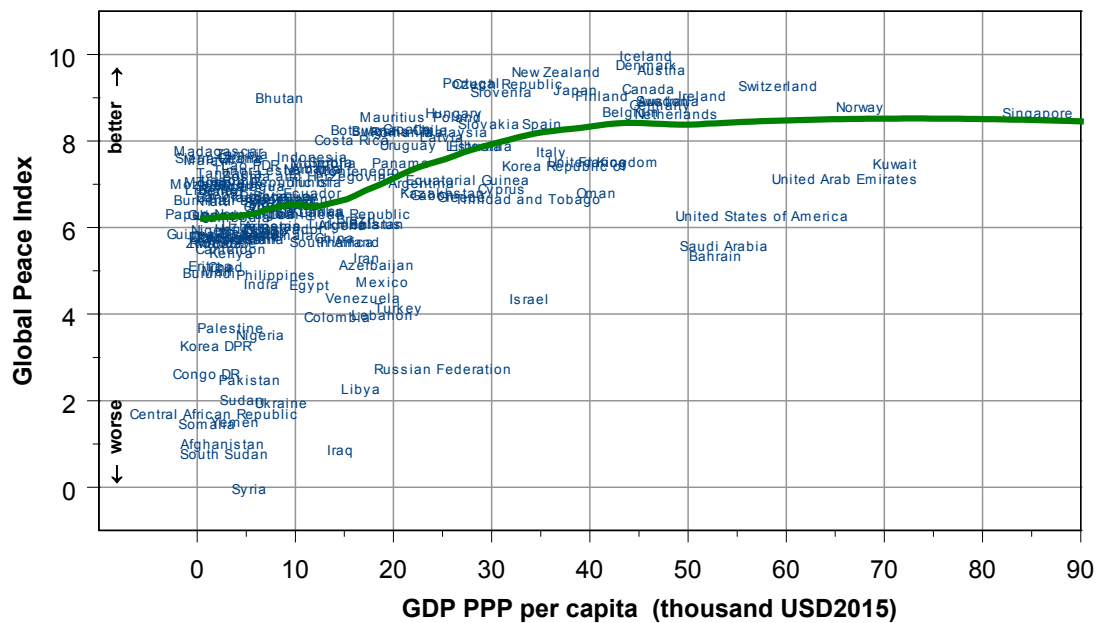
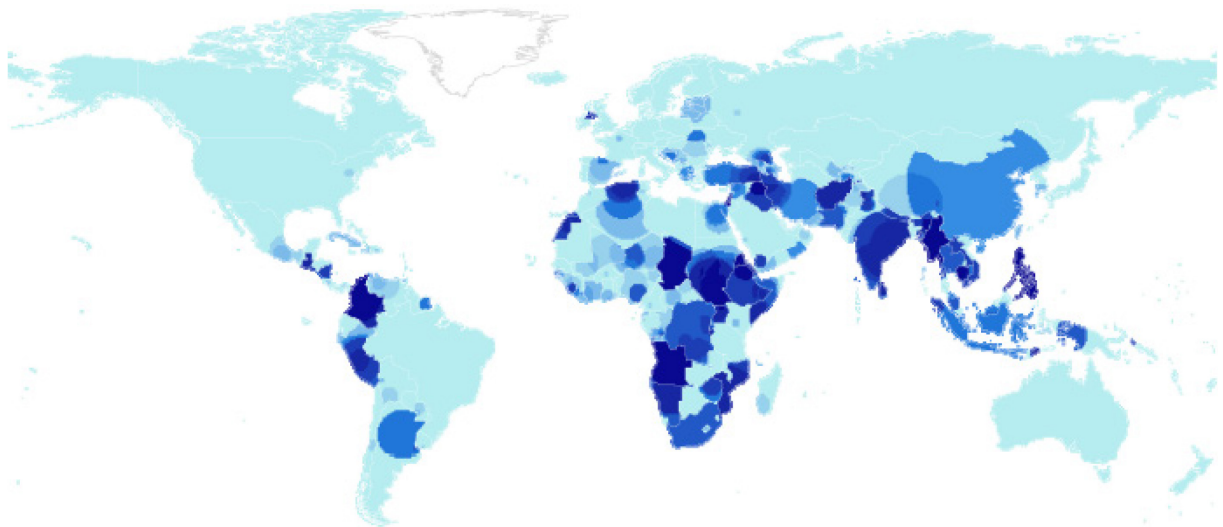


Figure 3.2 Idem for the relation between the Global Peace Index and GDP PPP per capita. One country has been left out: Qatar, with a GDP per capita of 140 and a Global Peace Index of 8.0.

### 3.2 Geographical distribution of conflicts

Conflict risk does not only correlate with certain socio-economic factors, but risks are also intertwined with geographic location. The risk of civil conflict is 7 to 10 times greater in drylands and tropical zones than in cooler, continental climate zones (Buhaug and Rudolfson, 2015). The explanation for this distinction is not well understood. Poverty, however, clearly is also related to drylands and tropical zones, however, the reasons for this are contested. Jeffrey Sachs et al. (2001) has argued that lacking agricultural opportunities, the prevalence of diseases and the restrictions to develop infrastructures for economic development has been the major causes of poverty in drylands and tropical zones. Climatic conditions have influenced human developments over a history of thousands of years, heavily influencing and reinforcing the 'unequal' distribution of wealth and power today (Diamond, 1998). These long-term perspectives on the interlinkages between climate, poverty and geographical location suggest that intensifying harsh climatic conditions in already vulnerable places may increase future conflict risk (map 3.1). Daron Acemoglu and James A. Robinson (2012) have argued however, that poverty in specific regions has nothing to do with environmental influences, but are all grounded in the presences of effective—economic—institutions.



Map 3.1 Global distribution of armed civil conflict since 1946. Darker shades indicate more durable zones of conflict (Buhaug and Rudolfsen, 2015).

### 3.3 The reverse relation: conflict and vulnerability to climate change

Environmental conditions can affect conflict risks indirectly in regions vulnerable to water-related problems. The reverse relation is less a topic of discussion though: regions facing (armed) conflict are highly vulnerable for climate risks and water insecurities (Buhaug, 2016; Peters and Budimir, 2016). This results from conflict and war causing massive destruction of infrastructure, lacking governance structures, capital flights and brain drain, thus strongly influencing vulnerability to climate change impacts (Adger et al., 2014). This reverse relationship emphasises the projection that wealthy and stable societies, having the resources and skills, will be capable to address climate-related challenges in a peaceful and equitable manner. In conflict-affected societies, struggling with political chaos, and social and economic inequalities, climate change and water-related problems are likely to reinforce the vicious circle of instability and underdevelopment (Buhaug, 2016).

# 4 Views and frames

The increasing attention from political, social and academic institutes in recent years has led to a growing body of research on water-conflict links on different scales (Allouche, 2011; Barnett and Adger, 2007; Bernauer and Siegfried, 2012; Buhaug et al., 2014; Burrows and Kinney, 2016; Link, Scheffran, and Ide, 2016; Rahaman, 2012; The Climate and Security Advisory Group, 2014; Wolf, 2007). This chapter discusses the different views and frames that are present within the field of research. Studies range from alarmist reports, projecting mass migration and violent conflicts as a direct consequence of drought and resource scarcity, holding conclusions often resonated by media, to nuanced case studies pointing to contextual factors like conflict history, inequality and demographics as driving force of future tension or even conflict (Al Jazeera, 2012; Buhaug et al., 2014; Defence Intelligence Agency, 2012; Gleditsch, 2012; Selby and Hoffmann, 2012; The Guardian, 2016).

## **Box 2: Immature Science?**

Thomas Kuhn defined different stages of science in his book *The Structure of Scientific Revolutions*. One of these stages is immature science, which means that the field of science is a promising area of inquiry, but that the field has no commonly accepted fields of observation, definitions, methods and scales. Salehyan (2014) coupled this conception of contemporary research to climate change and conflict relations. Many researchers observe some kind of relation between climate, water and conflict, but specifying these relations is contested and unclear. According to Salehyan, this notion presents an important juncture for theoretical development, developing a common language for scientists working on this topic.

## 4.1 Views

### **Views towards the role of water in conflict**

One group of studies underline the direct role of climate and water in political or violent conflicts (Homer-Dixon, 2001; Reuveny, 2007; Jürgen Scheffran and Battaglini, 2011). Some of these studies have statistically linked the increase in the prevalence of conflict to climatic and environmental changes, which supports the perspective of climatic change and changing water security being a major threat to global security (Cullen S. Hendrix and Idean Salehyan, 2012; Hsiang and Burke, 2014; Hsiang, Meng, and Cane, 2011). In line with this group of scientific studies, more policy-oriented studies present global warming and water-related issues as the 'ultimate threat multiplier' (NATO, 2015) for conflict or label them as key drivers of conflict in the coming decade (Defence Intelligence Agency, 2012).

A second group of studies is less explicit about the direct role of water in political or violent conflicts, and criticise the alarmist conclusions (Boas, 2015). At best, water is considered a subdominant factor in the conclusion of these studies, stressing the mix of determining factors are decisive, such as population size, demographic composition, governmental structures, poverty and inequality, ethnic fractionalisation, history of conflicts in the area or presence of neighbouring conflict (Allouche, 2011; Buhaug et al., 2014; Fjelde and von Uexkull, 2012; Gemenne, 2011; Schleussner, Donges, Donner, and Schellnhuber, 2016; O.M. Theisen et al., 2013; O. M. Theisen, Holtermann, and Buhaug, 2011; von Uexkull, Croicu, Fjelde, and Buhaug, 2016)

### **Views towards water as a tool**

Other studies point to the potential strategic value of water as a tool, for both cooperation and for conflict. These types of uses of water in political situations, do not per se exclude each other, what means that water may serve as a tool for cooperation in a certain situation

whereas water is used as a weapon in another case. Water has been used in former and may be used in future conflicts under conditions of scarcity or vulnerability (King, 2015; Nett and Rüttinger, 2016). This specific use of water during conflict is discussed within pathway eight. Moreover, there are also researchers who rather point to water as a conversation starter. Water-related issues could be a possible starting point for cooperation between countries in terms of river basin treaties, because of shared interests and possibilities for improved understanding (Brochmann and Gleditsch, 2012; CNN, 2015; Link et al., 2016; Wolf, 2007).

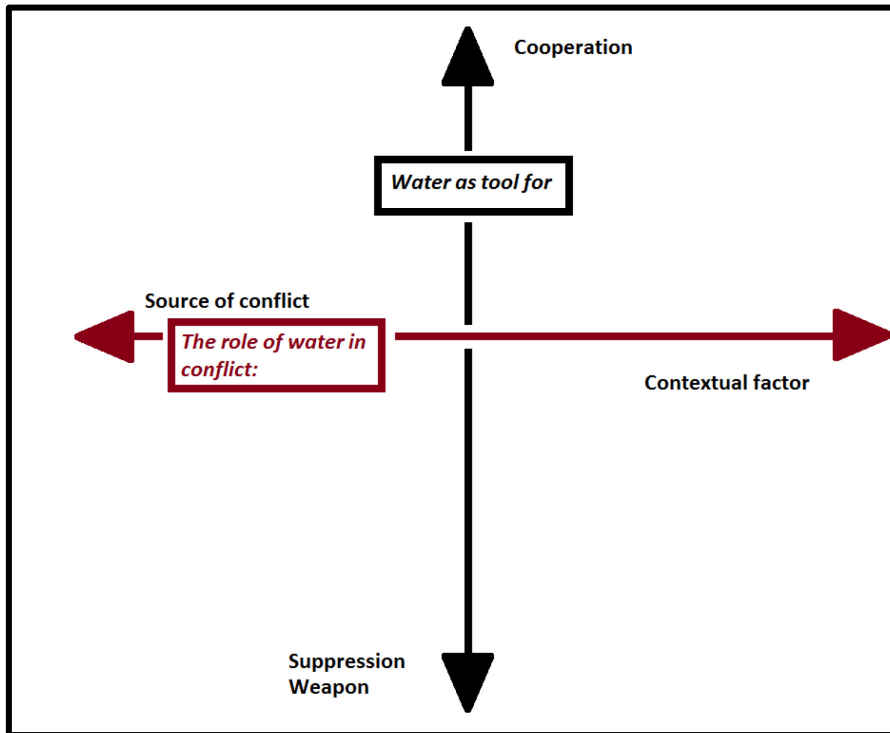


Figure 4.1 Conceptual simplification of the debate regarding view towards the link of water and conflict

### **Water and climate pressures resulting in peace?**

Finally, there are some researchers that conclude that future climate change, including water-related challenges, may decrease the chance on future conflict (Slettebak, 2012a; Tol and Wagner, 2010; Zhang et al., 2006). Some authors argue that climate change may create conditions forcing nations to 'get to the first handshake' (Gartzke, 2012), like water may be a reason for cooperation. Others conclude, based on (pre-) historical, long-term changes, that colder periods faced a higher number of conflicts on average, possibly due to food shortages, thus implying less conflicts in a warmer world (Tol and Wagner, 2010; Zhang et al., 2006). But since food shortages are, in the contemporary context, more likely because of global warming, this line of reasoning is not taken along. This study, therefore, sticks to studies on relatively short-term climate variability, except for pathway 10 on the Arctic region.

### **The securitisation of climate change: mainstreaming a debated topic**

There are a few scholars who criticised the growth of the climate, water and conflict research field, the so called 'securitisation of climate change', for two reasons. On the one hand, because it could lead to withdrawal of attention and resources from adaptation measures to military expenses, and on the other hand because relations are still so contested, that identifying risk regions could stigmatise (Boas, 2015; Brzoska, 2009; Hartmann, 2010). Thereby did a recent study criticise the climate-conflict research discourse, since too much of the research towards case studies would be focused on conflict areas, and only a few global regions would be represented (Adams, 2018). Contemporary case studies towards climate, water and conflict relations would be barely informed by climate change

vulnerability. This report does not only take water-related stresses into account caused by climate change (weather variations), but also includes socio-economic pressures and dam construction, since these pressures are at least as important, especially on the short term.

## 4.2 Frames

Although this report aims to stay agnostic in its applied research frame to understand links between climate change, water and conflict, it is important to acknowledge and understand the existence of different research frames. There are three main ways of framing this nexus, which are briefly described here.

The neo-Malthusian views claim that environmental degradation and climate change lead to resource scarcity, posing a direct threat to livelihoods thus increasing the likelihood of conflict (Bernauer, Böhmelt, and Koubi, 2012). Neo-Malthusians are 'resource pessimists'; increased resource scarcity will lead to decreased economic productivity and increased migration, resulting in weakened countries and different forms of conflict (Friedrichs, 2014). The neo-Malthusian theories are modified, more advanced versions of the famous Malthus theory on population growth and resulting resource scarcity, including societal processes of social and political power (Bernauer et al., 2012). Neo-Malthusian theories are directly linked to the Environmental Security discourse; advocating a semi-direct link between environment, resource scarcity discourses and conflict. Within this discourse, environmental impacts on social variables (migration, agricultural production, societal disruption, weakening institutions) can cause conflict on all geographical scales (Nel and Righarts, 2008).

The tradition of Political Ecology acknowledges the occurrence of resource-related conflict but seeks the explanation of these conflicts in governance and policy failures. Unequal power relations within resource disputes are an expression of these social and political relations (Selby and Hoffmann, 2014; Turner, 2004). Political ecology authors question the notion that conflict can be reduced to resource scarcity alone, by emphasising social and discursive contexts (Peluso and Watts, 2001).

The Cornucopian view dismisses the neo-Malthusian view as 'reactionary or deterministic' (Friedrichs, 2014). The term Cornucopian is less often literally mentioned in peer-reviewed studies, but can be observed in market-orientated discourses, following the idea that continued progress can be met by continued advances in technology and competition mechanisms. This view, closely related to eco-modernist thinking, can be described as resource optimistic: they acknowledge that resource scarcity may negatively impact human societies, but these moments of scarcity will result in adaptation and technological improvement (Bernauer et al., 2012). Humans will adapt through market mechanisms, the innovation of technology and redistribution. This view is not often literally mentioned in the academic literature but is an important discourse outside of academia.



# 5 Ten pathways linking water to conflict

In this chapter, 10 pathways linking water and conflict are presented, based on the methods discussed in Chapter 2. Only a limited number of scholars identify climatic and weather conditions as a direct cause of conflict (Homer-Dixon, 1994; Hsiang and Burke, 2014; Hsiang et al., 2011). Some of these studies are large statistical N-studies, which are contested within academia, due to sample selection methods and/or analytical coherence (Buhaug et al., 2014). Other case studies are criticised by their assumed simplistic, neo-Malthusian perspective on the narratives towards resource scarcity and conflict (Selby, 2014).

Most of the studies found are performed in the Global South, mainly in the northern Africa and the Middle East (MENA) and South Asia. This can be attributed to the fact that people living in these areas face relative high environmental risks and have relatively low adaptive capacities due to limited economic resources and institutional capacities (Wischnath and Buhaug, 2014). The case studies on water, climate and conflict relations use heterogeneous research designs and use of context variables, which makes it difficult to quantitatively compare the case studies.

The 10 pathways presented here analyse the contemporary discussion per link. These pathways are derived from popular narratives within media and academic studies and checked with experts in the field. Per pathway the level of evidence and agreement is given, the main discussion regarding the specific pathway, case studies and the main contextual variables that are distinguished within these case studies.

## 5.1 Local water stress

***Local water stress (drought, economic scarcity, inaccessibility) may induce or intensify conflict over remaining water and food in fragile contexts***

The local and direct link between water stress (due to drought, overexploitation and inaccessibility to water sources) and conflict over scarce resources, mainly food and water, is a popular narrative outside of academia (Balch, 2014; Sengupta, 2018). This link, often presented as undisputed by media, has also been studied by several scholars. Many of these scholars identify water resources—or related, local food scarcity because of water stress—as a conflict item, but often attribute the actual cause of scarcity to human mismanagement instead of weather-related drought (Allouche, 2011; Clionadh Raleigh and Urdal, 2007). Resource scarcity is often regarded as a result of a combinations of factors: policy failure, population pressure, resource degradation and the (unequal) distribution of resources between groups (Allouche, 2011; Clionadh Raleigh and Urdal, 2007). Instead of local water scarcity, or related local food scarcity, local risks of conflict are primarily explained by socio-political and geographic factors discussed in Chapter tree.

The six case studies given in Table 4.1 confirm that water stress only plays a role as a driver of conflict under specific conditions of existing and enduring poverty, economic inequality, mismanagement of water resources, and existing tensions. Within this line of argumentation,

local water scarcity alone is not a driver of conflict, but it can be a risk factor in already fragile regions.

Table 5.1 Case studies on climate/weather, water and food scarcity, and conflict

<b>REGION</b>	<b>CONTEXT</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>YEMEN, SOMALIA,</b>	Poor governance, unsustainable use of resources, poverty, opportunist insurgent organisations	Water scarcity leads to several issues, such as food scarcity and decreasing income. In poor arid and semi-arid countries, water failure encourages migration to cities, increasing stress on basic utilities, affecting political stability.	Robins and Fergusson (2014), Moench (2002)
<b>SAHEL REGION</b>	Access to resources, agricultural policies, poor livestock/farm management, historical relations between communities	Resource scarcity, including water stress, is not a primary cause for conflict in the Sahel. A context specific combination of social, political and economic factors spark conflict.	Turner (2004)
<b>AFRICA AND ASIA</b>	Extreme poverty, agricultural dependency, politically excluded groups, economic grievances	Conflict data over 1989-2014 shows that droughts in most situations have little effect. However, within vulnerable groups (in terms of socio-economic drivers) local drought is found to increase the likelihood of sustained violence.	Von Uexkull (2016)
<b>MALI</b>	Marginalisation of communities by state policies (politically excluded groups), embezzlement of drought relief funds	Drought itself, in the 1970s and 1980s, did not cause an uprising against the Malian state. The current marginalisation of the Tuareg and the following unequal distribution of aid caused mistrust and feelings of anger, which resulted in conflict.	Benjaminsen (2008)
<b>SUB-SAHARAN AFRICA</b>	Reliance on rain-fed agriculture, economic hardship, existing grievances between communities	Areas experiencing drought are more likely to see conflict when these areas already face sustained drought or are dependent on rain fed agriculture. This is because of economic grievances or to secure food and income.	Von Uexkull (2014)

### **Local water stress as contextual factor**

The case studies show that it seems unlikely that local water stress will be a single and direct cause for local conflict. Nevertheless, in combination with other variables such as poverty, insufficient diversified economies, marginalisation, and especially lacking governance structures, water stress can consolidate conflict (Moench, 2002; Robins and Fergusson, 2014; von Uexkull, 2014). However, according to a study by Salehyan and Hendrix (2014), drought may also have a countervailing effect on conflict. An example given in their study—which was not found in any other peer-reviewed case study and was therefore not included in this study—considers the droughts in Somalia. As a major drought gripped Somalia in 2010–2011, the impacts of this event weakened al-Shabaab al-Mujahideen, the major armed opposition to the national government (Salehyan and Hendrix, 2014).

### **Conclusion**

Increased conflict risks because of water stress in already fragile and conflict prone areas is described by a wide range of case studies, not only in academic literature but also by NGOs (Cordaid, 2015). Over 10 peer-reviewed studies<sup>7</sup> have been found assessing the link between water stress and local conflict. The level of evidence, therefore, is defined as robust. Although there is ample evidence, some scholars showed that there are contradictory conclusions and far more important drivers of local conflict, such as financial crises and bad governance (Theisen et al., 2013). Some studies claim that, instead of water stress, water abundance can increase the chance on conflict outbreak in regions dependent on regular rainfall (Cullen S Hendrix and Idean Salehyan, 2012; Salehyan, 2014; Ole Magnus Theisen, 2012); this pathway concerning rainfall variability will be discussed in Section 4.2. Most of the case studies point towards the possibility that water stress can be a risk in vulnerable contexts, although the conclusions of the studies by among other authors Benjaminsen (2008) and Turner (2004) would argue that water stress was not a risk factor in their case studies. Taking these discussions into account, the level of agreement is assessed as medium.

Table 5.2 Summary of pathway 1.

<b>Water stress as</b>	<b>Confidence</b>	<b>Context</b>	<b>Scale</b>
Risk factor for local conflict in vulnerable contexts	Robust evidence Medium agreement	Economically and politically deprived populations High dependence on rainfall Environmental mismanagement Lacking governance structures Tension/grievances between communities	Local

## **5.2 Variability in rainfall**

### **Variability in rainfall may influence the moment of local conflict outbreak and type of conflict in regions dependent on rainfall– increasing variability may lead to increasing levels of societal disruption**

Rainfall is a key climate variable in terms of its direct impact on societies, be it too much or too little, causing flooding or drought. But variability in rainfall patterns themselves, in terms of annual or monthly timescales, is by some scholars also linked to *the moment* of conflict outbreak in regions dependent on rainfall (Fjelde and von Uexkull, 2012), to the likeliness of

<sup>7</sup> Other case studies, among other studies, are described in: Adano et al. (2012), Leff (2009), Mustafa (2010) and Okpara (2015).

conflict (Cullen S Hendrix and Idean Salehyan, 2012), or the type of conflict observed (Witsenburg and Adano, 2009).

Literature covering this pathway is so far inconclusive and often contradicting: some studies claim that extreme variability in rainfall levels, more and less rain, can be linked to social disruption resulting in conflict (Devlin and Hendrix, 2014), whereas others claim that variability is not a decisive driver of conflict, but in some areas rather a risk factor (Buhaug, Benaminsen, Sjaastad, and Theisen, 2015; Ole Magnus Theisen, 2012; Wischnath and Buhaug, 2014). Some studies observe less violent events in on average dry years and months (Salehyan and Hendrix, 2014; Witsenburg and Adano, 2009), where others observe higher intensities of violence or increased chances on riots and conflict (Ember, Abate Adem, Skoggard, and Jones, 2012; Sarsons, 2011). Table 4.3 summarises five studies concerning the possible relation between rainfall variability and conflict.

*Table 5.3 Case studies on local variability in rainfall and conflict. Including location, context situation and the major conclusions of the study.*

<b>LOCATION</b>	<b>CONTEXT</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>AFRICA</b>	Not discussed.	Rainfall variability has a significant effect on large scale and smaller scale instance of conflict. Extreme derivations in rainfall correlates with all types of conflict, more likely due to abundance then shortage.	Hendrix and Saleyan (2012)
<b>EAST AFRICA</b>	Resource availability, political unrest and economic hardship.	Small-scale conflict increases under conditions of extreme rainfall variability. Anomalously dry years cause higher rates of rebel conflict while anomalous wet conditions trigger communal conflict.	Raleigh and Kniveton (2012)
<b>KENYA</b>	Densely populated areas, election years, presence of pastoralist communities.	Years with below average rainfall tend to have a peaceful effect on the following year whereas years with above rainfall are less save in terms of conflict.	Ole Magnus Theisen (2012)
<b>ASIA</b>	Level of democracy, GDP per capita, Population, Political exclusion, irrigated and rain fed cropland, conflict history.	A multi-scale empirical evaluation of climate-conflict connections across Asia is performed in this study. The effect of interannual climate variability (higher rainfall, loss of rainfall, higher temperatures) on conflict is inconsistent and sensitive to the scale of analysis. In countries prone to conflict, climate variability increases the chances on the outbreak of conflict, but economic and socio-political variables correlate better with conflict indices.	Wischnath and Buhaug (2014)
<b>INDIA</b>	Not discussed as explanatory variables in the text. According to the study, the percentage of young Muslim males; literacy	Negative rain shocks affect the likelihood of conflict, but not solely in agricultural areas directly dependent on rain for their income. Also, downstream districts (where water is secured via dams) face	Sarsons (2011)

	<p>and the number of migrants is correlated with violence. Therefore, these variables are used as control variables.</p>	<p>higher chances of conflict and riots during negative rain shocks, whereas positive rain shocks decrease the chance of conflict and riot in both up- and downstream districts.</p>
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**Conflicting findings**

The conflicting findings of different studies may be explained from different local contextual variables, such as social and cultural behaviour, and the local history of conflict. Eaton (2008) argues that fighting during dry years is suicidal in some pastoral societies facing direct scarcity (Eaton, 2008). Lacking rainfall, therefore, may lead to increasing levels of cooperation and reconciliation (Ole Magnus Theisen, 2012). But in other regions drought may lead to tension or even conflict over scarce resources due to increasing competition, depending on local social, political and economic constellations (Section 4.1). High rainfall variability may have important implications for income and the distribution of aid, impacting stability and trust in governments (Besley and Persson, 2011). And, following Raleigh and Kniveton (2012) type of conflict. According to Fjelde and von Uexkull (2012), the effect of rainfall anomalies on communal conflict will be larger in regions where people are economically and politically marginalised.

**Conclusion**

Future rainfall variability is projected to increase in many parts of the world when the planet continues to warm (Thornton, Ericksen, Herrero, and Challinor, 2014). Increasing variability may influence social disruption as a result of increasing livelihood insecurities. Especially in areas where farmers and pastoralist directly depend on rainfall for their daily livelihood, increasing variability may affect migration patterns of pastoralists and growing seasons of farmers. Seven studies<sup>8</sup> have been found assessing the link between rainfall variability and the effect on conflict, providing medium evidence for this pathway. However, since the case studies do not agree on the impact increased or decreased rainfall in a certain year may have on riots or conflict, the level of agreement is defined as low. Variability may have most impact in less-developed countries that directly depend on rainfall for livelihoods, with large differences per climate and cultural context. Therefore, this pathway cannot be generalised and only be understood within local contexts.

*Table 5.4 Summary of pathway 2.*

<b>Rainfall variability as</b>	<b>Confidence</b>	<b>Context</b>	<b>Scale</b>
Cause of societal disruption, leading to or influencing conflict outbreak	Medium evidence Low agreement	Direct dependence on rainfall for agriculture and cattle raiding Existing historical tension over land and water rights	Local

<sup>8</sup> Beside the case studies also the study by Fjelde and von Uexkull (2012) and Eaton (2008).

## 5.3 A shortage of fertile land

***A shortage of fertile land, resulting from land degradation and water stress (drought, economic scarcity and inaccessibility), may induce local conflicts over (remaining) fertile land, not necessarily at the same location or moment***

Water stress can be linked to a shortage of fertile land. In contexts of local dependence on fertile land for livestock grazing or crops, a shortage of land may result in local conflicts over fertile land, often elsewhere, where land is available. This mechanism is debated because of its focus on resource scarcity, where power relations (who has access to what land and for what reason?) and local histories are seen as at least as important, by a number of authors (Butler and Gates, 2012; Turner, 2004). Besides, conflict over land is often shaped by land policies and laws, which are received by communities as unfair or not legal. Table 4.5 summarises four case studies, emphasising context specific variables as land management and property right policies and economic marginalisation of certain groups within society. Unsustainable land use and insufficient water storage infrastructures intensify the impact of temporary water stress. It is important to note that conflict over fertile land cannot always be linked to absolute scarcity, but also to local abundance of fertile land or perceived inequality between different groups (Selby, 2014).

*Table 5.5 Case studies on water stress, fertile land and conflict*

<b>REGION</b>	<b>CONTEXT</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>NIGER, MALI</b>	Agricultural encroachment (obstructing the mobility of herders and their animals) due to policies and laws, decentralisation leading to political vacuums, corruption of government officials causing distrust in the state	This study gives little evidence for the impact of water scarcity on land-use conflicts primarily. Flooding can also induce conflict by expanding agricultural areas where no laws or norms are applicable.	Benjaminsen et al. (2012)
<b>KENYA</b>	Policies favouring tourism and agriculture over animal herding, leading to economic marginalisation of communities and the expansion of cultivation areas, population growth and migration	Conflict over fertile land between farmers and herders is caused by a combination of factors, of which drought is one of the most commonly identified sources by the actors themselves.	Campbell et al. (2000)
<b>SUDAN, SOUTH SUDAN</b>	Land disputes, migration, challenges to pastoralist livelihoods, colonial and post-colonial development practices	Relative abundance of water and fertile land locally (while absent elsewhere) caused conflict in different forms between communities. But the role of water should not be overstated: the presence of oil has been a major source of ongoing conflict in the Sudan.	Selby and Hoffmann (2014)
<b>EAST AFRICA</b>	Biased property rights management Resource asymmetries between pastoralist groups	Drought can affect the quality of grazing land in eastern Africa and thereby influencing pastoralist livelihoods. However, conflicts between different	Butler and Gates (2012)

groups of pastoralists should be understood not merely as resource-based conflicts, but rather as related to land allocation.

**Land shortage results from multiply causes**

Land use and the availability of fertile land can be affected by water shortages. However, the case studies show that conflicts over land use are hardly influenced by water stress. Conflicts over land are primarily related to the (un)equal access over land. Other examples of land use conflicts are also conflicts over autonomy in for example inner Mongolia (China). Land and water use conflicts can also be related to conflicts over water and land rights between (expanding) agrarian populations and land controlled by landlords, in developing countries often foreign investors cultivating for export (Goldstone, 2002), also conceptualised as land grabbing (Hall et al., 2015).

In these situations, water and fertile land are not scarce, per se, but access is unequally divided, according to protesting groups. Recent attacks on the farms of exporting Dutch floriculturists in Ethiopia are an example of local communities (that have been forcefully removed by the government to make room for foreign investments) hardly profiting from economic developments. These types of land and water use conflicts are also observed in Ecuador, among other countries (Mena-Vásquez, Boelens, and Vos, 2016). Besides the possibility of water stress causing conflict over remaining fertile land, the still small but increasing cultivation of biomass for biofuels has also been linked to increasing food prices (see pathway 4) and conflict over land use (Gerbens-Leenes, Hoekstra, and Van der Meer, 2009; Olsson, 2013).

**Conclusion**

Taken together over five case studies<sup>9</sup> have been assessed, discussing the link between water stress, fertile land and conflict risk. The level of evidence for this pathway is there for defined as medium. Land issues are often mentioned in water stress and conflict case studies, however, access to land is more often discussed as the key issue rather than the water stress, land scarcity and conflict link. The evidence for this link is therefore defined as medium. Since the case studies underline that land use conflicts are more often related to the way that land is divided, and to the division of profit, the level of agreement is defined as low.

Table 5.6 Summary of pathway 3.

<b>A shortage of fertile land resulting from water shortage</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
may be a threat multiplier for tension or conflict over remaining fertile land	Medium evidence, low agreement	Deprived populations High dependence on rainfall Absent or unequal land policies - Misuse of power by elite factions Existing tension between communities or international investors Incoming migration and population pressure	Local-regional

<sup>9</sup> Studies by Hendrix and Glaser (2007) and Turner (2004) also include land issues in their analyses.

## 5.4 Food price spikes

### ***Food price spikes, as a result of water related disasters (possibly in other regions) may accelerate or instigate local/regional riots or conflicts***

Food price spikes, a growing public concern inspired by uprisings during the Arab Spring, has increased the number of research projects towards the possible link between extreme weather events and its impacts on food production, related to food price spikes elsewhere and conflicts as riots and rebellion. Protests and food riots are not new phenomena and have been associated with several historical political and social changes, as the French Revolution and the Russian Revolutions. Global interrelatedness of food markets has led to impacts of regional drought on food prices rising globally, especially hitting net food importing countries. Whether or not weather conditions affect food security, of which food prices is a part, depends largely on national governance structures and vulnerability of crops grown. Table 4.7 gives four case studies.

*Table 5.7 Case studies on food price spikes and conflict*

<b>REGION</b>	<b>OTHER DRIVERS</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>SUB SAHARAN AFRICA</b>	Local poverty, unjust government policies, corruption, repression, market failure	A robust link is found between weather patterns and food production. But agricultural output and conflict are only weakly connected, suggesting social and political variables are more important.	Buhaug et al. (2015)
<b>SAHEL</b>	Existing economic and social grievances, poverty, weak institutions	Direct relations between acute food insecurity (high prices) and conflict are not the case, it can even dampen the risk of conflict behaviour. But food insecurities can be a factor in popular mobilisation and a threat multiplier in conflict.	Hendrix and Brinkman (2013)
<b>URBAN AREAS OF AFRICA</b>	Underlying economic and political grievances and unrest	Sudden monthly increases in food prices, regardless of the price rise causes, (1990-2012) have significantly increased the probability of urban unrest, especially spontaneous events and riots, in that specific month. The rise in food prices is linked to local rainfall scarcity and international grain commodity prices.	Smith (2014)
<b>CHINA, EGYPT</b>	Global economic interrelatedness of food exporter China and importer Egypt, current civil unrest in Egypt, high percentage of income spend on food (in Egypt)	Drought in China caused a rise in global wheat prices in 2011. Increasing wheat prices indirectly influenced social instability in Egypt and other countries in the Middle East.	Sternberg (2012)



### Food price spikes as tipping point

Rising food prices are not regarded as an actual root cause for riots or conflict among scholars. Within a context of unequal economic access to food, corruption and repression and little social and economic perspective, food price spikes may function as so-called 'tipping points' for the outbreak of already imminent riots or even revolutions, sometimes ending in violent conflict (Buhaug et al., 2015; C. Hendrix and Brinkman, 2013; Lang and Ingram, 2014). This is because deprived people may have grievances towards elites and the state, or they may feel they have little to lose when it comes to social or economic security. This group is inclined to follow when a small group starts to riot, hoping to improve conditions. Figure 4.3 shows global world food prices and several food-related riots. A contemporary example of this type of unrest is Venezuela, although it is not related to climate change and water. After years of corruption, extreme inflation, political suppression and related, rising food prices, many Venezuelans are rioting, hoping that President Maduro will resign and conditions will improve (Al Jazeera, 2017). Shortage of water is, evidently, not always a (sub) cause for increasing food prices. Growth of agricultural demand because of increasing populations, changing policies, economic growth in export or import regions, economic crisis (local, national), rising meat consumption (related to economic growth), changing prices of fertilisers, fuel and seeds, price traders speculating on the price of food and the production of crops for biofuel production can be main drivers of increasing food prices (Hilderink et al., 2012; Piesse and Thirtle, 2009).

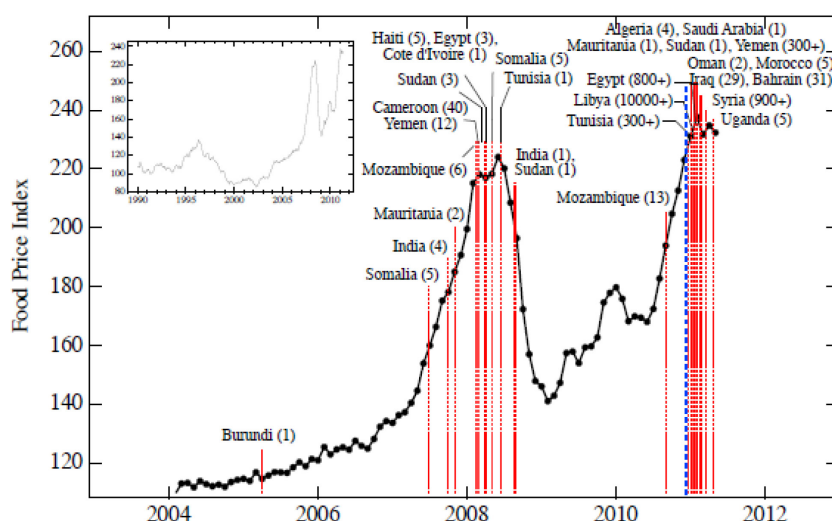


Figure 5.1 Food prices following the FAO Food Price Index. Red lines indicate food riots and protests associated with major recent unrest in northern Africa and the Middle East (Lagi, Bertrand et al., 2011)

### Conclusion

There are a number of case studies<sup>10</sup> showing that food price spikes can serve as a tipping point for the outbreak of riots or even conflict (Bellemare, 2015; Piesse and Thirtle, 2009). Over 10 cases have been identified, and therefore the level of evidence is defined as robust. The role of water shortage is not undisputedly listed in these studies as the major factor for food price rises, the influence of market related mechanisms and governance is often mentioned as at least as important. Food price spikes do not lead to conflict per se, the study by Smith (2014) even found a conflict dampening effect resulting from price spikes. Here, policy mechanisms are important for the possible effect of food price spikes on people's lives. Therefore, the level of evidence is defined as medium.

<sup>10</sup> Other studies towards water shortage, food prices and conflict/social unrest are: Natalini et al. (2015), Piesse and Thirtle (2009), D'Souza and Jolliffe (2013) and Papaionnou (2016).

Table 5.8 Summary of pathway 4.

<b>Food price spikes as a result of water stress</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
As tipping point or risk factor for social disruption, the outbreak of riots, possibly resulting in civil conflict	Robust evidence Medium agreement	Economically deprived populations, high percentage of income spend on food Misuse of power by elite factions Existing grievances against elites or the state Political instability	Local–global relations

## 5.5 Migration and displacement

### ***Migration and displacement may increase as a result of water related disasters, possibly causing tension or even conflict in receiving areas***

Linking water-related issues to migration and displacement, possibly resulting in conflict due to increasing pressure on social and economic structures in receiving areas, is again a contested link (Burrows and Kinney, 2016; Tacoli, 2009). A difference is made by the International Organisation for Migration (IOM) between migration and displacement, also defined as forced migration (IOM, 2018). Displaced people are those who are forced to move because of physical impacts because of sea level rise, flooding, storms or conflict, whereas migrants move for economic or educational reasons or marriage. In some cases, labour migration can be related to the environmental degradation of the migrants' living environment (Gray, 2011; Marchiori, Maystadt and Schumacher, 2012). But this separation is often blurry: it can for example not easily be said if people who move because of salinisation due to sea level rise, are moving voluntary or forced (Richard. Black, Arnell, Adger, Thomas, and Geddes, 2013).

Between 2008 and 2015, an average of 21.5 million people per year have been displaced by weather-related events, mainly due to flooding and storms (IDMC, 2016). The number of people that migrate as a result of slow-onset events such as land degradation and salinisation is not included in this number, since it is hard to track migration down to one cause. Often are slowly changing environmental changes just one of the causes that people move, and these changes are interrelated with socio-economic and political contexts (Ionesco, Mokhnacheva, and Gemenne, 2017).

Estimations towards future numbers of environmental migrants and displaced people in 2050 range from 50 million to 1 billion (Christian Aid, 2007; Government Office for Science, 2011; Tacoli, 2009). Little agreement exists on the actual importance of climatic conditions for migration in view of socio-economic opportunities and existing conflict (Burrows and Kinney, 2016; Selby and Hoffmann, 2012). Some scholars see clear links in areas where people directly depend on their physical environment (Reuveny, 2007; Warnecke, Tänzler, and Vollmer, 2010), where others suggest that too much weight has been awarded to environmental drivers of migration (Brzoska and Fröhlich, 2016; Selby and Hoffmann, 2012). Migration is always complex and the result of multiple push and pull factors, Figure 4.2 shows the many factors influencing the decision to migrate. Not all people who would like to migrate are able to do so though, since some resources are needed to move, especially to move to another county. This so called trapped populations is vulnerable to stress due to environmental change (Black et al., 2013).

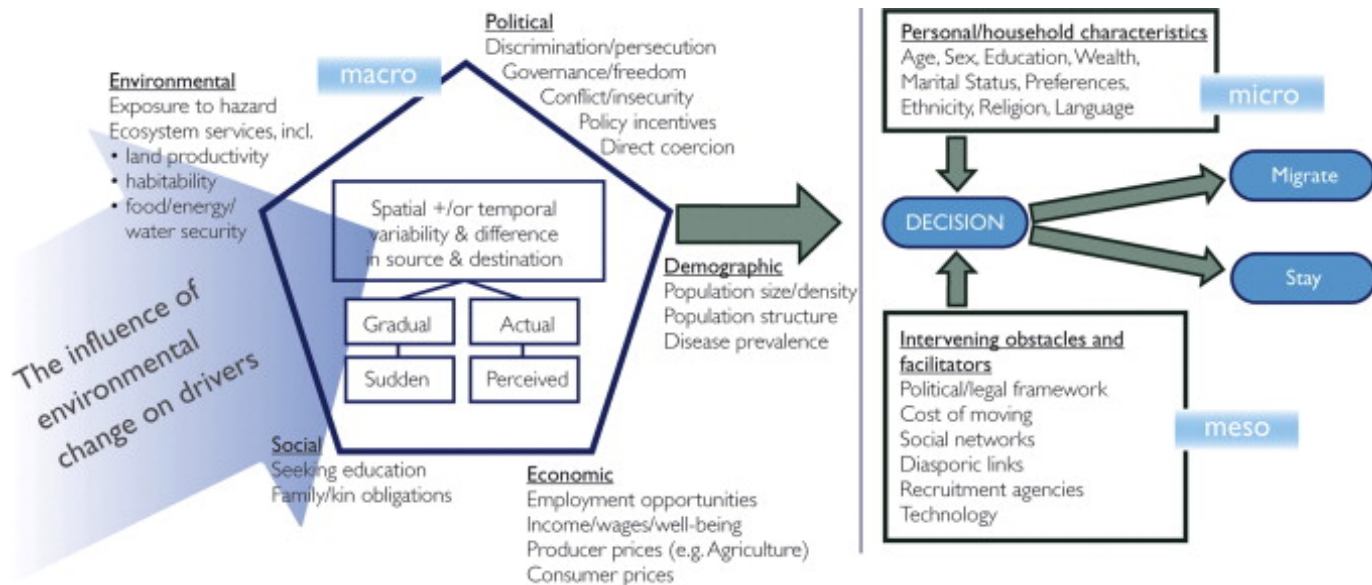


Figure 5.2 Drivers of migration and the influence of environmental change (Black, Adger et al., 2011).

In recent decades, a sharp increase has been observed of migration from rural areas to urban areas. Urbanisation can be mainly attributed to (perceived) economic and social pull factors from urban areas. To a lesser degree this flow can be related to environmental degradation, mostly caused by human mismanagement. Many of these migrants migrated to economically developing deltas, but these deltas are often vulnerable itself to climate change as a result of sea level rise (in combination with soil erosion and sinking), flooding and storms (Seto, 2011).

### **Population growth and youth bulges**

Despite declining population growth in parts of the global North, large parts of Asia and Sub-Saharan Africa will continue to experience high levels of population growth rates, now and in the futures. These areas are also the areas projected to face the most severe consequences of climate change (Stern, 2007). Taken together, these developments will arguably influence and reinforce current migration flows and numbers of people displaced because of natural disasters. Especially in the least-developed counties contemporary population growth has caused large youth bulges, causing social, environmental and economic challenges, beside opportunities. Some researchers claim that the growth of youth bulges is related to different types of conflict and state repression due to exclusion and lacking opportunities (Goldstone, 2002; LaGraffe, 2012; Nordås and Davenport, 2013). Other studies see youth bulges as a proxy for little development and instable governments instead of the major driver of unrest (Urdal and Hoelscher, 2009). And although the link between youth bulges and these political and socio-economic variables is not undisputed, it is likely that groups of migrants may increase when economic possibilities lack and environmental conditions degrade.

### **Migration as coping mechanism**

Although academic discussion exist among the actual weight environmental variables have on migration, the UN Refugee Agency sees the links between climate change, disasters and environmental degradation, and displacement as undisputed (Goodwin-Gill and McAdam, 2017). Fact is that temporary migration during dry seasons has always been a coping mechanism of human communities directly depending on seasonal variability, especially in large parts of Africa and the Middle East (Barrett and Santos, 2014; Brown, 2015). Increasing water stress in vulnerable areas are projected to increase this number of seasonal migrants, together with growing populations, or make migration permanent instead of temporal. Chronic environmental degradation, such as long-lasting and reoccurring drought and increasing soil salinity, generally first leads to intensified labour migration patterns to increase remittances locally (Raleigh et al., 2008). Displacement or temporarily migration

due to extreme flooding has also always been a coping mechanism, possibly intensifying existing tension in receiving areas (Richard Black, Bennett, Thomas, and Beddington, 2011; Ghimire, Ferreira, and Dorfman, 2015). Table 4.9 summarises six case studies discussing this specific pathway.

Table 5.9 (Case) Studies on environmental changes, migration and conflict

<b>REGION</b>	<b>OTHER DRIVERS</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>BANGLADESH</b>	Low economic development, little economic perspectives	Migration or 'population displacement' is regarded as an adaptation measure to natural disasters by Bangladeshi people. In India huge numbers of Bangladeshi immigrants (mostly due to non-environmental drivers) led to high ethnic tension and the construction of a border fence between India and Bangladesh.	Mallick and Vogt (2014), Black et al. (2013)
<b>BOLIVIA AND PERU</b>	Low economic development, little economic perspectives, mismanagement of water and land resources	The increase in labour-related migration due to increasing droughts leads to ethnic conflict over remaining resources between farmers in receiving areas and migrants.	Hoffman (2013)
<b>SAHEL</b>	Massive population growth, poverty and food insecurity, chronic political instability, direct dependency on natural resources	Climate change does not act as a single variable for migration, but environmental change does affect issues linked to natural resources needed for local livelihoods, resulting in increased levels of migration and possible conflict over remaining resources.	UNEP (2011)
<b>VIETNAM</b>	Livelihood security, poverty	Sudden-onset events, such as flooding, increase the likelihood of migration, while slow-onset events, such as salinity, reduces migration (triggering adaptation).	Koubi et al. (2016)
<b>SYRIA</b>	Poverty, rising food prices, bad water and land management, feelings of injustice about created resource inequity due to nepotism, imbalances of power, revolutions in neighbouring countries	Agricultural policies since 1980 increased the vulnerability of small farmers. The extreme droughts of 2007–2010, therefore, forced them to migrate, which by some scholars is regarded as one of the causes of the Syrian uprisings. This case is highly contested and sensitive in the current situation.	De Châtel (2014), Gleick (2014), Kelley et al. (2015), Fröhlich (2016), Feitelson and Tubi (2017), Selby et al., King (2015).

The case studies show that permanent migration usually occurs in situations in which people live in poverty and with little future perspectives, or in already conflict-prone areas. Especially the Syria case is a hotly debated event and is therefore elaborated in Box 3.

**Box 3. Drought, migration and conflict: the contested Syrian case**

Some studies state there is evidence of lingering drought in the Fertile Crescent having contributed to political unrest, via agricultural failure, livestock mortality and large-scale migration (Kelley, Mohtadi et al., 2015; King, 2015). Certain scholars, however, opposed this firm conclusion by showing that there is no reliable evidence of antropogenic climate change having impacted the droughts in Syria, let alone that these droughts caused pre-conflict migration or that migration levels affected conflict risk (Selby, Dahi et al., 2017; Fröhlich, 2016). Fact is that some parts of Syria are short on water and this has caused problems in agriculture, resulting in higher food prices. This is not only caused by weather patterns, but also largely the result of resource mismanagement, leading to humanitarian problems (De Châtel, 2014; Feitelson and Tubi, 2017). All together, it is not possible to measure the relative contribution of increasing water stress prior to the Syrian War. There is, however, conclusive evidence about decreasing harvests (due to resource mismanagement or drought) having added to rising food prices, economic marginalisation of farmers and temporary migration (Gleick 2014).

**Conflict in receiving areas**

Even when environmental degradation, disasters or climate change (partly) cause migration, this does not automatically lead to conflict in receiving areas. Climatic and non-climatic variables may strain governance capacities of receiving areas and weaken the stability and the natural resource base of receiving communities, thus making it harder for them to respond to migration appropriately (Warnecke et al., 2010). Migrants will, if they have the resources, most likely not move to areas where climatic conditions are harsh (Feitelson and Tubi 2017). However, in general is migration to environmental risk zones bigger than the number of people moving away from risk zones, especially migration to growing cities in the flood-prone coastal regions of developing regions in Asia and Africa is increasing (Ionesco et al., 2017).

Brzoska and Fröhlich (2016) identified three types of receiving areas that are conflict-prone as a result of in-migration:

- *Regions with extreme resource scarcity:* if receiving areas already face absolute resource scarcity (food, water) for different reasons, incoming migrants may be seen as competitors, possibly increasing tension or even conflict.
- *Regions with high level of conflict:* in regions where tension over identities or interests are high, the potential of migrants to become a conflict driver or trigger of conflict is relatively high (compared with peaceful areas), especially when migrants influence identity conflicts.
- *Regions with exclusive identities:* when migrants arrive into communities unwilling to accept others, tension or even conflict can arise. This can occur due to political discourses emphasising economic scarcity due to migrants, or within communities fearing the erosion of traditions, when migrants are perceived as different and threatening.

**Conclusion**

To what extent migration is driven by water-related issues, is a hotly debated issues nowadays. Conclusions differ, although especially rural communities in developing countries are perceived as vulnerable since their livelihoods are largely depending on their natural environment. The link between 'environmental migrants' and conflict is even more contested, since it is very hard to trace down migration to one cause, and since the conditions in receiving areas are by far not only defined by the number of incoming migrants. Taken together, over five case studies have been found discussing the water, migration and conflict link. The level of evidence is therefore defined as medium. However, the conclusions of the case studies differ widely, since numerous other factors are defined as the real causes for tensions, the level of agreement is therefore defined as low.

Table 5.10 Summary of pathway 5.

<b>Water security threats as</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
Causes of migration, causing tension/conflict in receiving communities	Medium evidence Low agreement	Demographic composition of originating and receiving areas Economically and politically deprived populations, food insecurity Conflict in receiving and/or originating areas Networks of migrants Political freedom	Local–international

## 5.6 Economic shocks

***Economic shocks, because of rapid-onset water-related disasters, can increase inequality that adds to social disruption and grievances, and increases conflict risk***

Hydro-meteorological natural disasters,<sup>11</sup> such as flooding, hurricanes and drought, are common drivers of economic shocks, by some scholars linked to conflict on different scales (Besley and Persson, 2011; Nel and Righarts, 2008). This link is related to pathway 1, 2 and 4 but deals more specifically with fast-onset disasters, that cause direct economic shocks.

This link may manifest itself in the first place via the direct shocks of these disasters on wages, infrastructure and the distribution of aid, possibly affecting conflict risk. Since already poor people are often vulnerable to natural disasters due to little resources to cope with the effects on the longer term, the impacts of these events hit them harder than richer people. Besides, poorer people are more often settled in disaster-prone areas, like lower parts of deltas (Hallegatte et al., 2016). These conditions can intensify the impacts of disasters like societal chaos (looting) declining local safety nets and protective patterns, possibly creating political tension, changing power structures or migration, and even increase the level of human trafficking (Nett and Rüttinger, 2016).

Nel and Righarts (2008) define the structural effects of natural disasters on conflict in terms of motives, incentives or opportunities. Motives are affected by grievances because of poverty, inequality, displacement, and marginalisation. Incentives can arise because of acute needs because of increased competition. Opportunities can arise due to decreasing state abilities or other declining power structures because of natural disasters. This link discusses explicitly the short and long-term impacts because of too much water, and related, shocks

<sup>11</sup> Following the CRED EM-DAT database, disasters can be classified in hydro-meteorological disasters (droughts, extreme temperature, flooding, landslides, storm surges, wildfires and storms), geological disasters (volcanic eruptions and earthquakes) and other disasters (famine, insect infestation and epidemics).

due to extreme weather like cyclones, storms and events like the tsunami in Southeast Asia of 2004<sup>12</sup>. These events, likely intensified by future climate change, hit poor people on the most vulnerable places hardest, because coping capacities are lacking (Hallegatte et al., 2016). Table 4.11 summarises studies linking natural disasters to conflict.

Table 5.11 Studies on the impact of natural disasters on conflict

<b>REGION</b>	<b>OTHER DRIVERS</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>WORLD</b>	Middle and lower income countries, income inequality, instable regimes, conflict history, youth bulges	Natural events can cause shocks in already instable regions that increase grievances in already conflict-prone areas, while reducing state ability to respond.	Nel and Righarts (2008)
<b>SRI LANKA</b>	Lingering economic and social suppression of ethnic groups (Tamils), unfair distribution of aid after the 2004 tsunami	The 2004 Tsunami in Sri Lanka infused the already precarious politics of ethnicity and class, generating more polarisation and ground for conflict.	Hyndman (2007)
<b>PAKISTAN</b>	Existing ethnic and religious tension and terrorism, distance to political capital and economic deprivation	The 2010 floods caused food insecurity in certain regions, health issues and regional displacement. The flood may have also contributed to increased conflict and instability as a result of, among other things, the inability of the central government to adequately respond.	Kronstadt, Sheikh, and Vaugh (2010)
<b>HAITI, VIETNAM, GAMBIA</b>	Poverty, (sometimes) inadequate aid, low to moderate governance effectiveness	Analysing separate countries based on EM-DAT data, GDP per capita and governance data, several countries face high vulnerability to natural disasters, but no signal of increased conflict risk because of the combination of factors.	Kaufman and Kraay (2015)

### **Cooperation as a result of natural disasters**

Although the case studies provide some examples of perceived links between natural disasters and conflict, some scholars claim these conclusions draw attention away from the real causes of conflict, namely poor governance and poverty (Slettebak, 2012b). Others support this view by concluding that an increase in future natural disasters will not, based on historical data, cause more conflict, even though this will diminish economic development (Bergholt and Lujala, 2012). This conclusion can be endorsed by the observation that large-scale conflicts hardly occur in countries prone to natural disasters (Adams, Ide, Barnett, and

<sup>12</sup> The 2004 tsunami in South-East Asia is not direct climate related but serves as an interesting example of a natural disaster impacting conflict risk.

Detges, 2018). According to another study, completely contrary to the inclination of this pathway, natural disasters increase the likelihood that parties will talk or initiate ceasefires, instead of increasing chances on conflict (Kreutz, 2012). An example is the political situation in Aceh, Indonesia after the 2004 tsunami. Here rebel groups and regional governments started working together in order to rebuild the destroyed areas, opposing to the development of already lingering ethnic conflict in Sri Lanka (Beardsley and McQuinn, 2009). These contradictory events had everything to do with the state of the conflict, the role of the government and the goals of the rebel groups.

**Conflict**

It is likely that extreme events in terms of heavy rainfall, heatwaves and possibly also tropical cyclones will increase in the future resulting in a growing number of people affected, physically and economically (IPCC, 2013)<sup>13</sup>. There is medium evidence in scientific literature concerning the link between natural disasters and conflict via economic shocks. The studied link between natural disasters and conflict is contested though, since some studies find a robust link, whereas others find that cooperation is far more likely after a disaster. The level of agreement is therefore defined as low.

Table 5.12 Summary of pathway 6.

<b>Economic shocks</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
As a result of natural disasters, economic shocks can lead to societal disruption, possibly adding to grievances, increasing conflict risk	Medium evidence Low agreement	Low adaptive capacity, grievances, unfair distribution of aid (increasing grievances), poverty trap	Local - regional

## 5.7 The construction of mega dams

***The construction of mega dams may lead to tension/conflict between riparian countries in a context of distrust and lacking governance mechanisms***

In multiple river basins, less water will be available on the long term, due to climate change or/and increasing use by upstream riparian countries. Even though increasing water stress has been linked to a heightened risk on hostile interactions between riparian countries (Bernauer et al., 2012), sharing river water resources has more often led to collaboration than conflict (Wolf, 2007). This pathway specifically assesses the possible impact of the construction of mega dams on tension between riparian countries (De Stefano, Petersen-Perlman, Sproles, Eynard, and Wolf, 2017)

In recent decades, numerous mega hydroelectric dams have been constructed, under which the three Gorges Dam (China), Itaipu Dam (Brazil, Paraguay) and the Guri Dam (Venezuela),<sup>14</sup> to meet increasing demands for energy. Where some see hydroelectric dams or dams for irrigation purposes as the solutions for sustainable development, others consider the construction of these dams as untransparent processes where human rights and ecology matters are considered less important than economic benefits (Zarfl et al., 2015).

<sup>13</sup> See also annex 1 on global flood risks in cities.

<sup>14</sup> Together these three dams produce almost 250 TW-hour per year (1000 times the yearly electricity use of Dutch households).



Historically, dams have had severe impacts on local communities. An estimated 80 million people have been displaced by dam projects worldwide (Walicki, Ioannides, and Tilt, 2017). The faith of these people is large unknown, but evidence shows that those affected do often not receive compensation, and the majority of these people remained or became poor (Moore, Dore, and Gyawali, 2010). Social justice and conflict issues have occurred among other countries in Colombia (Martínez and Castillo, 2016), Chile (Carruthers and Rodriguez, 2009), Myanmar (Kirchherr, J. Charles, and Walton, 2016) and Brazil (de Azevedo, Miranda, and Gomes, 2016).

More dams are planned to be constructed in the future, especially in Latin America, the Balkans, Asia and Africa (Gernaat, Bogaart, van Vuuren, Biemans, and Niessink, 2017; Zarfl, Lumsdon, Berlekamp, Tydecks, and Tockner, 2015)<sup>15</sup>. These changes may alter current tensions or even create new ones, from local to transboundary scales, strongly depending on the way these dams will be constructed (De Stefano et al., 2012; De Stefano et al., 2017). Food security is likely to be undermined, local communities living along river banks are under threat of losing their livelihoods, and migration may be triggered, all possibly impacting already existing tensions, on a local scale (Abbink, 2012). Table 4.13 gives four main contemporary examples of tension over water use in river basins, related to the construction of dams for irrigation and energy.

Table 5.13 Case studies on transboundary tensions due to the construction of dams

REGION	OTHER DRIVERS	CONCLUSION	SOURCE
<b>PAKISTAN– INDIA: INDUS BASIN</b>	Conflict over territory and power, geopolitical tensions, little trust/cooperation	India is constructing massive electricity generating turbines, whereas a 50-year-old treaty gives Pakistan the right to use all the water. This further intensifies a situation that is already politically sensitive between the two countries.	Bagla (2010), Grumbine and Pandit (2013)
<b>UZBEKISTAN, TAJIKISTAN, KYRGYZSTAN: SYR DARYA</b>	Historically strained political relations, low levels of trust unequal power relations, conflict over control	After the collapse of the USSR the Syr Darya and Amu Darya turned from domestic to international rivers, causing international disputes over water allocation ever since. All these countries need water for thermal cooling and irrigation. Dominant Uzbekistan and Kazakhstan depend on Kirgizstan, which causes tension, likely to grow in the future because of increasing demand and impacts of climate change. However, a militarised interstate conflict does not seem very likely.	Bernauer and Siegfried (2012)
<b>ETHIOPIA, EGYPT, SUDAN: NILE BASIN</b>	Historically strained political relations, unequal power	Several agreements give Egypt the right to use a major share of the Nile, while	Arsano and Tamrat (2005), Abbink (2012)

<sup>15</sup> See Annex 1 for an overview of globally planned and potential hydropower dams.

	relations, conflict over former agreements	Ethiopia uses the least amount of water from the Nile run-off. Ethiopia is planning to construct several hydroelectric dams what causes political conflict between countries and social injustice to indigenous tribes. Especially the Renaissance Dam in Ethiopia, a mega hydraulic dam under construction since 2011, is considered to be a major security threat for both transnational conflicts and social injustice locally.		
<b>THAILAND, LAO, CAMBODIA, VIETNAM, CHINA: MEKONG BASIN</b>	Local and regional dependence on the river, low institutional capacity	The rapid development of hydro-power in China poses a concern for lower basin countries (Thailand, Laos, Cambodia, Vietnam), whose energy and food consumptions are growing explosively. Flows of sediment diminish because of dam construction, gradually causing a sinking delta. These developments cause interstate tension between the basin countries, but this is unlikely to cause militarised conflict.	Pearse (2012)	-Sm it

The case studies show that these transboundary tensions related to the construction of dams are often related to power issues and historical distrust between countries that share rivers. Although the narrative of so-called 'water wars' between countries may sound frightening, cooperation in river basins is reality among most river sharing countries (Brochmann and Gleditsch, 2012; Link et al., 2016; Subramanian, Brown, and Wolf, 2014; Wolf, 2007). Aaron Wolf, an often cited scholar specialised in transboundary water conflict, considers an increased likelihood of conflicts within basins the result of insufficient institutional capacity and rapid physical changes within a basin (Wolf, 2001). Wolf considers the creation of new riparian countries and the development of large-scale dam projects as the most rapid changes that can take place (Wolf, 2001). It is hard, if not impossible, to project future political developments such as the emergence of new nations, the construction of dams can be better foreseen. In combination with weak institutional capacities of countries, the combination of these stressors can increase risk on political tension<sup>16</sup>, but militarised conflict between countries as a result of dam construction is unlikely in the near future.

Over 10 peer-reviewed case studies<sup>17</sup> have been found assessing the link between the construction of dams and transboundary tensions, especially in river basins where trust

<sup>16</sup> Map E in annex 1 shows an overview of river basins at risk globally due to dam construction.

<sup>17</sup> Other case studies found concern the Danube between Hungary and Slovakia (Galambos 1993), the Ganges between Bangladesh and India (Rahaman 2009), the Euphrates and Tigris between Turkey and Syria (Jongerden 2009), Ethiopian Omo River between Ethiopia and Kenya (Abbink 2012), the Helmand River and the Harirud between Afghanistan and Iran (Thomas and Warner 2015) and the Salween river between Myanmar, Thailand and China (Magee and Kelley 2009).

between riparian countries is low and governance mechanisms are lacking, the level of evidence is therefore defined as robust. The level of agreement is defined as medium, since the literature agrees on the observation that the construction of large-scale dams can influence tension between riparian countries, however, the exact impact depends on the political situation in the basin. Discussion exists towards the importance of river basin treaties (De Stefano et al., 2017) and governance (Karreth and Tir, 2017). No violent conflict has been observed solely as a result of the construction of a large dam, and the emerge of a certain conflict is not likely.

Table 5.14 Summary of pathway 7.

The construction of dams	Confidence:	Context	Scale
As a possible threat multiplier for tension between riparian countries when trust is low and governance mechanisms are lacking	Robust evidence Medium agreement	Existing grievances and distrust between countries Rapidly developing projects Rapid political changes Little institutional capacity	Transboundary

## 5.8 Water as weapon or strategic tool/measure

### **Water may be used as a weapon or strategic instrument in situations of conflict**

Water infrastructures are vital for the organisation of societies and destruction can pose a threat to societal stability or intensify conflict; blocking water facilities or sewage plants, poisoning wells or bombing dams can all have tremendous effects. There are several legends, myths and historical events in ancient Middle-Eastern countries, such as Iraq, in which water was used as a weapon during conflict (Hatami and Gleick, 1993).

Not only physical infrastructure, also the digital systems controlling water facilities may be attacked (Gleick, 2006). There are three ways water can be used as a weapon: (1) by taking action that restricts the availability of water, (2) by flooding areas, and (3) by poisoning water resources. Too little water may affect sanitation and food provision, and may result in energy scarcity when areas depend on hydropower (von Lossow, 2016a). Fragile environments can be further destabilised by the strategic use of water, because these actions often diminish access for civilians, causing unrest. These mechanisms can exaggerate scarcity and tension, possibly intensified by climate change (Nett and Rüttinger, 2016).

Especially the damaging large dams may affect thousands of people. In 1975, two dams in China accidentally failed in sequence, destroying dozens of lower dams, resulting in the death of 85.000 people (Gleick, 2006). Even though this event was an accident, it shows the power water can have during conflict. In 2014, IS flooded around 200 square kilometres of fertile farmland, livestock was killed and the harvest was destroyed, causing the loss of 60 000 livelihoods (von Lossow, 2016a).

Table 4.15 summarises six case studies in which water has been used a weapon during conflict. Some case studies are slightly older, but these studies have been included to underline the observation that the use of water as a weapon during conflict is not a contemporary phenomenon.

Table 5.15 Studies on the use of water resources as a weapon

<b>REGION</b>	<b>SITUATION/CONTEXT</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
<b>IRAQ, SYRIA</b>	Islamic State originated partly from other terrorist groups in the Middle East region and grew stronger during the current civil war in Syria.	Islamic state has been using water as a strategic tool in several occasions. Taking control of dams, flooding areas to divert groups, cutting of water from rebelling communities. IS also used water as an asset to fund war activities.	King (2015), Nett and Rüttinger (2016), von Lossow (2016a)
<b>LAKE CHAD</b>	The terrorist group Boko Haram in the Lake Chad region poses enormous security threats for local populations. Aiming to install an Islamic state in Nigeria, Boko Haram is attracting huge numbers of unemployed young man in the region (50% of Nigeria's population is under 15 years old).	Boko Haram has been poisoning vital water sources, according to the Nigerian military. This would imply an intensification of already compounding climate-induced water scarcities.	Nett and Rüttinger (2016)
<b>UKRIANE-THE CRIMEA</b>	Since the occupation of the Crimea by Russia, lingering tension between Russia and Ukraine have intensified. Ukraine is holding power over vital water infrastructures in the Crimea.	Ukraine blocked a main water canal (providing 80% of the Crimea's water supply), causing serious water scarcity from 2014 onwards.	Hughes and Sasse (2016)
<b>NORTH KOREA</b>	During the Korean war in the 1950s, US troops fought in Korea as an ally of South Korea.	U.S. war strategy involved attacking dams in North Korea.	Westing (1980)
<b>IRAQ, KUWAIT, UNITED STATES</b>	The Gulf War	Iraq destroyed much of Kuwait's desalination capacities to weaken the country.	(Gleick, 2000)
<b>ISRAEL, PALESTINE</b>	The ongoing Israel-Palestine conflict because of the Israeli occupation.	Israel is holding power over the water sources declared as Palestinian areas after the Oslo Accords of 1993. The Palestinian Authority cannot construct water infrastructure without permission of Israel. In addition, Israel often destroys rainwater-harvesting cisterns.	Zeitoun (2008), Amnesty International (2009)

### ***Is climate change a risk factor?***

Even though there are numerous studies on the historical use of water as a weapon during all types of conflict<sup>18</sup>, little has been written on using water as a weapon in future conflicts, in a context of climate change. A recent report warns for the possibility that terrorist groups will increasingly exploit natural disasters, food shortages/prices, and water stress (Nett and Rüttinger, 2016). Climate change will, according to this report, fuel the recruitment of people in deprived situations for terrorism. In addition, resources such as food and water may become increasingly scarce and therefore more powerful when used as a weapon. Although these future perspectives may sound plausible, it is important to stress that, among other aspects, manmade water and land policies will be at least as important in order to prevent the use of water as a weapon in future conflict.

Since water has been used as a weapon in numerous occasions throughout history, over 10 peer-reviewed case studies have been found, the evidence for this pathway is defined as robust. Also, the level of agreement on these cases is high because there is little to no debate on the role of water in this narrative, a role that results from conflict rather than being a possible cause of conflict. However, the importance of climate change for this pathway is contested.

*Table 5.16 Summary of pathway 8.*

<b>Water resources and infrastructure</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
Can be used in conflict situation as a weapon or strategic goal	Robust evidence High agreement	Existing conflict, conditions of scarcity or vital infrastructure	Local - regional

## **5.9 Water resources and reservoirs as strategic/military target**

### ***Water resources and reservoirs can be pursued by nations or terrorist/rebel groups as strategic/military target under conditions of water stress***

Will nations in the future fight 'water wars'? This pathway is the most speculative one, especially in the light of climate change, but often discussed in media (Parker, 2016; Rasmussen, 2011). In media articles, all types of local or international 'water wars' are often put together, however, this specific narrative discusses the proposed possibility of nation states or political groups starting a conflict to gain power over a water reservoir. As discussed, access to and control over water is of strategic importance for all countries. Different from pathway 4.8 on the (unfair) use of international waters, this pathway concerns the strategic occupation or invasion of land, partly motivated by the presence of (ground) water. Because social and economic activities most often take place in areas where water is present, conflicts are hardly fought over desert land, as is the case in Syria, where fighting does not take place in the largest part of the country, the desert. The occupation or possession of water rich areas have been (sub) causes in the two case studies summarised in Table 4.17.

*Table 5.17 Studies on water resources as (military) target*

<b>REGION</b>	<b>SITUATION</b>	<b>CONCLUSION</b>	<b>SOURCE</b>
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<sup>18</sup> See the Water Conflict Chronology List with over 100 examples going back to 3000 BC (some are religious accounts), giving numerous examples of how water has been used as a weapon in history.

<b>CHINA-TIBET</b>	Lingering conflict over the status of Tibet, over power, identity and territory.	China did not occupy Tibet for its water resources, initially. But since China faces enormous water scarcity in the dry north of the country currently, Tibet is used as a 'water tower', extracting enormous amounts of water via canals. Climate change (large parts of glaciers have already melted), together with the overexploitation of water resources, are projected to increasingly cause shortages, also in Tibet.	Schneider and Pope (2008), Gleick (2009)
<b>ISRAEL-YRIA (GOLAN HEIGHTS)</b>	In 1967, Israel occupied the Golan Heights, a strategic plateau. According to Israel itself this was motivated by safety and protection issues.	Water was an important factor in the conflict between Israel and Syria between 1949 and 1967. Nowadays the Golan Heights provide a third of Israel's water supply.	Hof (1997), Amery (2002), Dillman (1989)

### ***Little evidence of water wars between countries***

Only two case studies have been found that clearly show a link between large water reservoirs and conflict, which makes the amount of evidence limited. In addition to these examples, some conflicts have been found in the Water Conflict Chronology of the Pacific Institute in which water reservoirs have been considered as a military target. However, these events fit the 'water as a weapon' pathway better, since the reservoirs are often destroyed or not used by the occupying actors.

Both the conflict in Israel/Syria and China/Tibet is about much more than the water reservoir alone. In both cases are territorial disputes leading (Hof 1997, Schneider and Pope 2008). However, both the Tibetan plateau as the Golan heights are water rich regions with underground springs, whereas Israel and especially northern China are water stressed areas with increasing water demands. The Tibetan plateau with her large glaciers is even considered to be the largest freshwater repository after the polar icecaps (Chellaney, 2009). High government officials from Israel and China view the Golan Heights and Tibet respectively as main water sources for the drier parts of their own country. The former Prime Minister of Israel, Yitzhak Rabin, considered a withdrawal from the Golan Heights in the early 1990s, when water and security demands would be met by Syria (Amery, 2002).

Although little can be said regarding the future likeliness of this slightly speculative pathway, it is not impossible that forthcoming occupations or invasions in water-stressed regions will be partly influenced by the presences of water, but this may not very likely be the major driver. The level of agreement for this pathway is set as medium, since there is some agreement that water played a role in the occupation of the Golan Heights and Tibet, nonetheless, other reasons are brought forwards as more or equally important.

Table 5.18 Summary of pathway 9.

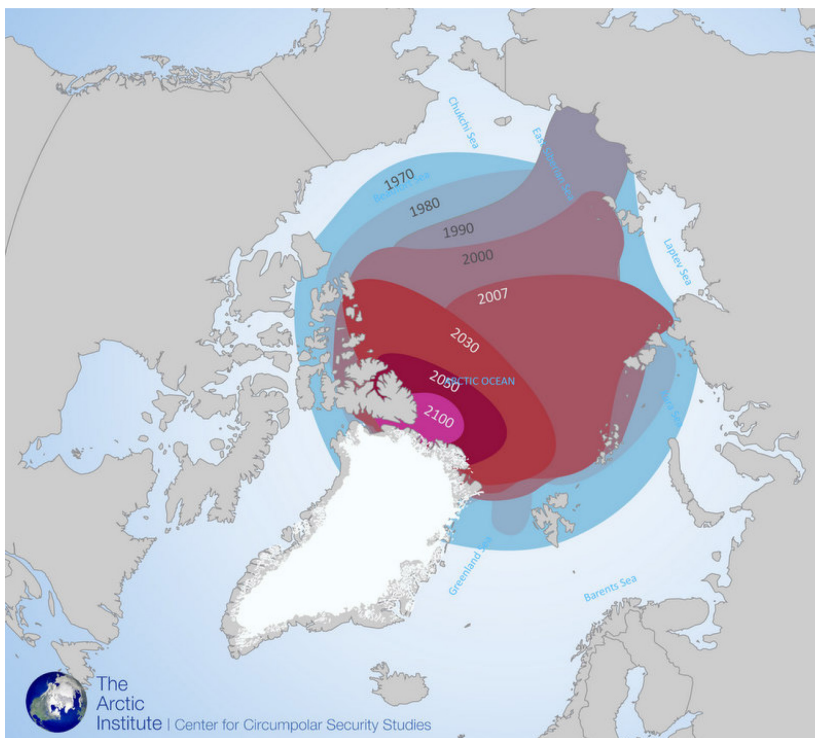
<b>Water resources or water reservoirs</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
As strategic/military (sub) target under conditions of water stress	Limited evidence Medium agreement	Existing tension between nations, suppression, (perceived) water stress, history of conflict	International

## 5.10 A melting Arctic

### ***A melting Arctic may change regional geopolitical relationships and cause interstate tension or conflict***

A rapidly melting Arctic will change the physical conditions in the Arctic region, possibly influencing the political conditions on an international scale. When the Arctic ice continues to melt (map 4.2), this region will, seasonally, open up to new shipping routes (map 4.3), and new, relatively abundant supplies of oil, gas and minerals will become available (Rekacewicz, 2015). The physical changes may transform the Arctic from a scientifically interesting region and living area of indigenous people into a maelstrom of competing economic, political and environmental interests and security issues (Åtland, 2014; Ebinger and Zambetakis, 2009; Hovelsrud, Poppel, van Oort, and Reist, 2011). The developments may trigger different levels of tension between, local communities, environmental organisations, countries and commercial actors. This narrative has not only been studied by academic researchers and security experts, but has also extensively been addressed in the media (Goldenberg, 2014; Rosenthal, 2012; Watson, 2017).

According to some studies, these competing interests can result in escalating geopolitical tensions or even armed conflict between the nation states present, when no clear rules will be set (Berkman, 2012; S. G. Borgerson, 2008; Ebinger and Zambetakis, 2009)<sup>19</sup>. However, according to others, the security discourse of the Arctic ignores many salient developments in cooperation and human security agendas, arguing that the balance is in favour of cooperation rather than conflict (Nicol and Heininen, 2014). Other drivers such as external geopolitical tensions or lacking governance mechanisms could be of more importance for the security dynamics in the Arctic region than the actual physical events in the region itself (Hovelsrud et al., 2011; Young, 2011).



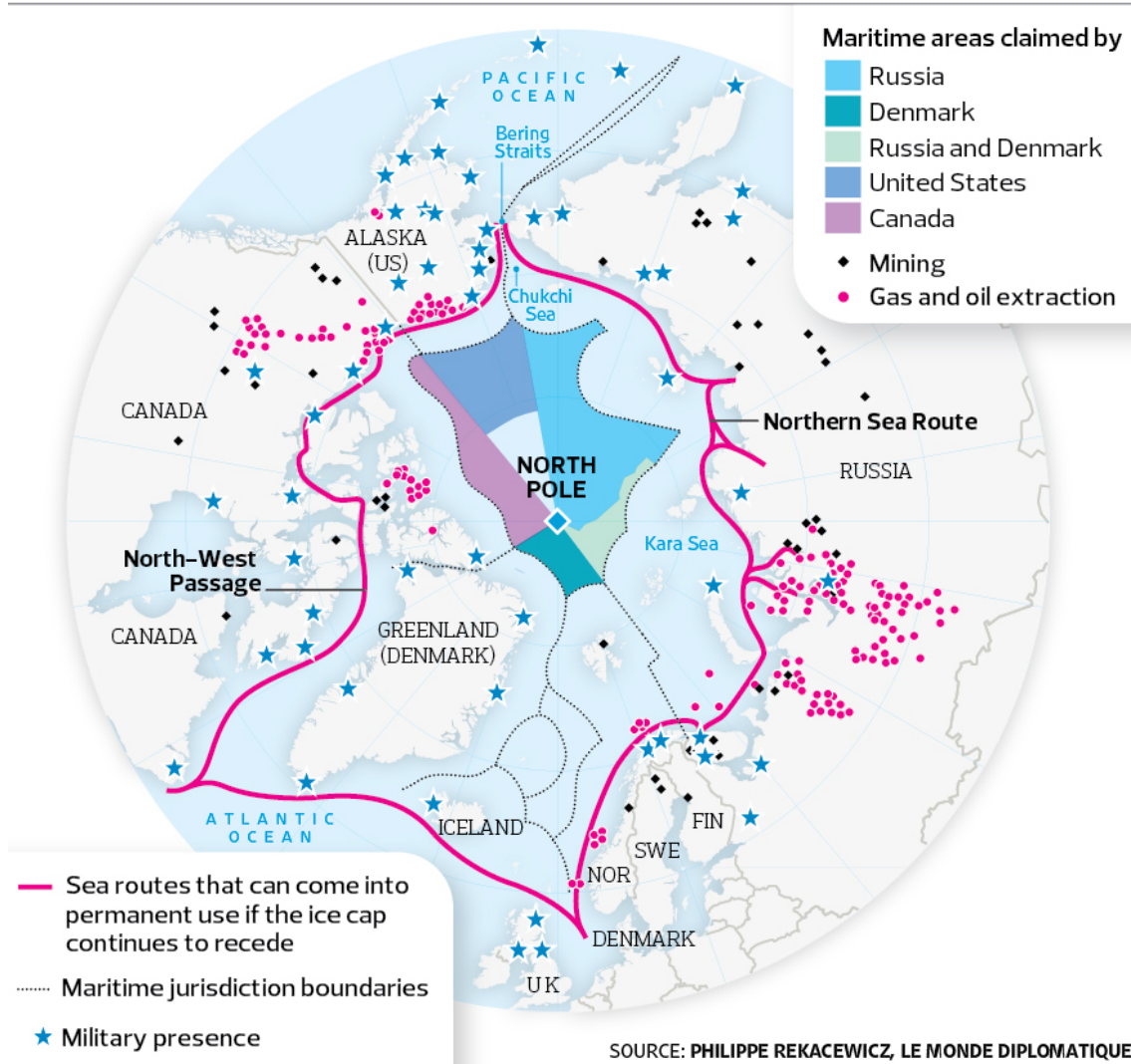
Map 5.1 The Arctic region; past, current and projected future ice cover (Humpert and Raspotnik 2012)

<sup>19</sup> Borgerson changed his view towards the likelihood of armed conflict in an article of 2013 (Borgerson, 2013). In this article he corrects his rhetoric about 'armed conflict' of 2008 and argues for a more nuanced and cooperative view upon the region.



Geographically, the Arctic region comprises the Arctic ocean, which is largely international water, and the land surrounding it. Politically, eight countries are present in this polar region: Denmark, Finland, Norway, Iceland, Sweden, Canada, Russia and the United States. Since 2010, China is also developing its activities in the region, lobbying for a permanent observer status in the Arctic Council (Rosenthal, 2012). Map 4.3 displays the geographic Arctic region, the claims countries have on it, including the presence of military bases and resources.

## OPENING UP THE FAR NORTH



Map 5.2 Countries, (claimed) territories, resources and shipping routes in the Arctic (McKie, 2012)

The UN Convention on the Law of the Sea<sup>20</sup> has provided global territorial guidelines since 1982, where the Arctic council has served the interests of its members and fostered cooperation since 1996. But since the Arctic Ocean belongs to no country and the UN often lacks the institutional capacity to streamline, haggling over sea borders has begun between neighbouring countries, such as Canada and the United States (Ebinger and Zambetakis, 2009). But these disputes are not expected to easily escalate into violent conflict between countries, especially when no other conflict develops between involved countries, since stakes are high and the international community is watching closely (Ebinger and Zambetakis, 2009; Rosenthal, 2012).

<sup>20</sup> This convention gives Arctic countries the right to economic activities up to 200 nautical miles from their shoreline.

### ***Influence in the Arctic region means geopolitical power***

The current and future economic interests in the Arctic with regard to oil, gas and mineral resources may, beside competition, challenge the traditional ways of life from native communities, and add to the changes these communities face due to the direct effects of climate change (Nicol and Heininen, 2014; Rekacewicz, 2015). These exploitation activities can lead to increased adaptation costs elsewhere or regional environmental degradation due to pollution, besides the melting of ice. But also the new shipping routes may alter geopolitical relationships, especially when political tension increases at traditional shipping bottlenecks and in channels where potential military conflicts are already brewing (Ebinger and Zambetakis, 2009). The blue lines in map 4.3 show Arctic shipping routes, which are not all (yet) fully accessible. The Northwest Passage first became ice free in 2007 and the Transpolar Sea Route may become available in coming decades (Humpert and Raspotnik, 2012).

Beside the policy studies by security and defence institutes, over 10 peer-reviewed studies have been performed towards the link with a melting Arctic and security concerns, the level of evidence is therefore high. The studies assessed have, however, different conclusions. Some studies see a substantial risk for conflict in the changing physical conditions in the Arctic region, where others see more options for cooperation between countries, considering the high cost a conflict in the Arctic region would imply. The level of agreement is therefore defined as low.

*Table 5.19 Summary of pathway 10.*

<b>A melting Arctic</b>	<b>Confidence:</b>	<b>Context</b>	<b>Scale</b>
Will impact shipping routes and reveal resources, possibly changing geopolitical relations	Robust evidence Low agreement	Existing grievances and distrust between countries Conflicting national interests Little communication and openness	International

## **5.11** Overlapping mechanisms

The 10 pathways that have been addressed address the different roles water may have in relation to conflict. However, these linkages on different scales can be generalised since the same broad mechanisms are observed. The case studies show that the context in which they occur are different per pathway, but similar to general conflict risk factors. Water-related events may affect conflict risk by:

- deepening poverty, lowering thresholds for individuals to engage in developing unrest/insurgency, since there is less to lose;
- deepening inequalities between both people and nations, fuelling feelings of grievances;
- accelerating changing power relations on all geographical scales as a result of increased inequalities;
- unequal distribution of remaining resources or aid resources, which may lead to increasing competition under conditions of scarcity or grievances.

# 6 Discussion

## 6.1 Beyond the pathways

Before discussing the actual findings and their theoretical integration and practical implications, a notion towards the completeness of this report needs to be made. Ten pathways have been presented, including underpinning case studies and a brief discussion on uncertainties and different views. These pathways are the links presented most often in media and academic articles, pathways that can be supported with, sometimes contested, evidence. However, the aim of this report is not to pretend that all imaginable relations are covered; more pathways can be thought of, present in the form of projections, speculations or not well-reported realities. These other imaginable relations linking climate change, via water, to conflict risk are mostly presented by governmental think tanks, and hardly supported by scholarly research. The following four pathways are increasingly brought forward by think tanks:

- Global health issues and pandemics due to water quality issues as a possible result of global warming may influence security risks in several ways (Hawa, 2017);
- Continuing urbanisation in combination with climatic change may pose security issues when livelihood securities for the poorest diminish further (Nett and Rüttinger, 2016; Vivekananda and Bhatiya, 2017).
- Climate change may influence bottlenecks in various ways: directly via high water levels or drought (less water surface for transport) impacting the navigability of a bottleneck, or indirectly via impacts on society. Severe disruption at ports, straits or inland shipping routes impact global trade in a negative way, possibly impacting food security (Bailey and Wellesley, 2017; Goldstein and Samaras, 2017)

But since these narratives are not, or hardly, supported by academic studies or case studies, they are not included as specific pathways in this report.

## 6.2 Immature science? Definitions and scales

When analysing the case studies and model studies to underpin the 10 pathways presented, the notion of immature science, discussed in Box 3 (Chapter 4), turned out to be highly relevant. The conception, proposed by Thomas Kuhn and applied by Salehyan (2014), on the field covering climate, water and conflict, is well applicable on this field of inquiry. A common language in the field of climate and conflict research is lacking, even with respect to applied methods and geographic and timescales, although little people will deny that a relation between climate, water and conflict exists. A 'cacophony of findings' (Salehyan, 2014) is the result, providing policy makers and practitioners with seemingly incompatible findings. Adams et al. (2018) claim that climate–conflict relations are elusive, due to 'heterogeneous research designs, variables, data sets and scales of analysis' (Adams et al., 2018).

Besides or resulting from differences in ideological frames, the definitions of concepts varies greatly among the studies assessed. As an example, one of the important variables in almost all case studies is the economic condition of the actors involved. This concept is explained in various terms and parameters in different studies: economic hardship, economic marginalisation of communities, poverty, low economic development, little economic

perspective, income inequality, and economic deprivation are expressions used to address economic inequality and underdevelopment. Geographic scales also differ greatly: ranging from the household level up to the transboundary level (Nel and Righarts, 2008). And furthermore temporal scales vary widely, since some studies only analyse direct effects of natural events where others also consider time-lagged events. Most studies analyse short-term 'shocks' as a result of extreme events or changing variability in rainfall or temperature. Short-term impacts are likely to have different bearings on societal processes than long-term impacts of climate change over several years.

Societal scale also varies; social processes may differ greatly between communities due to cultural practices. In other words, drought would affect a certain community differently due to its culture and economic activities than other communities. This is also the case for countries; different countries with different histories and regimes, are likely to react very different on the same impacts of human- or climate change related environmental changes due to social and cultural differences. All studies not necessarily have to apply a certain temporal, geographical or societal scale, but a more clear accountability and explanation for certain choices needs to be made.

### 6.3 Implications and importance

So, what can these findings tell us in order to estimate future risks? The results provide an in-depth understanding of uncertainties and factors affecting the risk on water-related conflict. Water security threats alone are not likely to cause conflict; but the impacts of water security threats can affect human security. Governance structures and economic development and interests are decisive in how natural hazards or man-made changes impact society, and especially the poor in less-developed countries. Drought in Australia is far less likely to add to conflict than a drought in Yemen, since human and political security aspects are better facilitated in Australia so widely supported grievances that could lead to conflict are hardly present. In order to decrease vulnerability to climate change and conflict risk, poverty reduction is key. Fair economic development and capacity development in vulnerable countries has the potential to lead to an increased level of international safety, regardless of climate change.

#### ***Can historical patterns be extrapolated to the future?***

It is important to note that most of the research used for this study is based on historical data and case studies. It is not clear to what extent historical precedents may inform us about the future. And while important studies have been done on issues touching on climate change, migration and conflict, the scale of these long-term challenges may be far greater than our collective action to understand and solve them. Taking into account global interdependence due to globalisation, changes in human capacities or possible climatological tipping points, it is hard, if not impossible, to predict impacts of water-related changes on conflict (Cederman and Weidmann, 2017; Feitelson and Tubi, 2017).

#### ***Additional research needed for hands-on policy recommendations***

Reality is more complicated than outlined in the abstraction made in this report. And although accurate forecasts focused on the physical world are already elusive, some climate and socio-economic trends are clear. Populations and economies will continue to grow and cause an increasing demand for water in a context of climate change. Water governance changes should be long-term reforms; political security and human security are much easier to sustain when water governance is arranged well. Without stable and well-functioning institutions, it is hard to see how both individuals and societies can address future water-related challenges. Underlining shared interests over water between communities, sectors and countries is an important starting point for cooperation when it comes to water. It is,

therefore, of importance that both the political sphere of trust and cooperation, human development, environmental conditions, and vulnerability are addressed, since these aspects all affect each other. This implicates that increased attention for water security threats in conflict-prone areas should be part of international cooperation and development programmes.

To further elaborate on hands-on policy recommendations, additional research towards the pacifying effect of water resources on local and international level is needed. Water is a potential source for collaboration, and therefore could be an element of peacebuilding processes or conflict prevention. Especially in developing adaptation programmes, it will be of interest to know how water can spur conflict management and better livelihood outcomes. What social, economic or institutional frameworks have proved to be effective in what conflict situation, and how is water accounted for?

# 7 Conclusions

Based on historical and ongoing case studies and overview studies, this report has assessed the contemporary debate on the possible links between climate, water and conflict. Two research questions are at the core of our assessment of this debate: 'How can we understand the often-contested outcomes of studies on the interaction between water, climate and conflict?' and 'What pathways can be distinguished linking water insecurities to conflict, and what is the contemporary level of evidence and agreement towards this specific pathway?'.

These questions have been answered in four steps. After clarifying methods and definitions in Chapter 2, Chapter 3 has described difficulties within conflict research when it comes to definitions and methods. The chapter summarises in a mostly qualitative way major drivers of conflict. Chapter 4 discusses views and frames when it comes to the field of water, climate and conflict. Chapter 5 presents 10 pathways that have been composed from literature, especially peer-reviewed case studies.

## ***Contested findings in a developing field of research***

The analyses outlined in this study point out that contestation on the exact relations and mechanisms remain, especially when it comes to cause and effect relations. This is partly due to differences in research methods, ranging from qualitative case studies to large scale statistical studies. The use of data is a second issue when it comes to methods. Data on both conflict and climate-related water availability are difficult to compare in a quantitative way due to differences in geographical and temporal scale/resolution, uncertainties regarding the time lapse relationship between conflict and water and differences in the used definitions of conflict and in the used environmental variables.

A second way to understand the differences in outcomes is the way studies are framed. The Syrian case is a striking example (see Box 4, Chapter 5). Some authors see drought in the Syrian region as a major cause of the current war, since especially rural people were marginalised as a result of water stress, decreasing rural income levels, causing migration and increasing tensions elsewhere. Other scholars argue that this regional drought did not cause conflict in neighbouring countries, and that it impacted Syrian people especially because of the corrupt government, affecting water management practices. In this second view, water stress was an effect of the existing governance structures rather than a cause.

## ***Ten pathways linking water to conflict***

Ten pathways are identified and elaborated between water security threats and conflict, to improve understanding of the existing debate and the state of research. Water insecurities are in hardly any study mentioned as the sole cause of conflict. Contextual factors define the role of water. Risks may derive from the social and economic impacts of water insecurity, economic shocks due to rainfall variability and natural disasters and the distribution of power over water, in situations of conflict and distrust between nations. No link between water quality issues and violent conflict have been found, even though water quality issues lead globally to far more casualties than conflicts (PBL, 2018).

The identified pathways are summarised in Table 6.1. Dozens of case studies have been found supporting these narratives, however, as mentioned, conclusions and methods of the studies differ widely. The pathway that explains the use of water as a weapon during conflict is the only pathway that is rather undisputed. This is probably because this link does not propose a causal role to water in conflict but shows the instrumental value of water during conflict. Three pathways (concerning local water stress, food price spikes and the

construction of dams) are found to have robust evidence, thus over 10 case studies per link. However, the case studies supporting these pathways do not always arrive at the same conclusions and for all three pathways the actual context, mainly governance and inequality related, are decisive. The pathway discussing possible geopolitical tensions as a result of a melting Arctic differs from the other linkages in several ways. One could wonder whether disappearing Arctic sea ice counts as a threat, rather than an opportunity. Thereby does this link only consider one case, because there is only one North Pole. For this pathway the number of peer-reviewed studies towards the possible geopolitical tensions due to a melting Arctic have been analysed, providing a robust level of evidence. Four of the identified pathways—regarding rainfall variability, fertile land scarcity, migration and displacement, and economic shocks—are supported by between 5 and 10 peer-reviewed case studies. These different linkages are frequently mentioned in overview studies and conceptual studies, however, not that many contemporary case studies are available towards these pathways. The final pathway discusses if water reservoirs may be strategic military target by nation states or terrorist groups. Only two well documented cases have been found, that of Tibet and the Golan Heights. This pathway has been included nevertheless, to underline that historical events provide little evidence of so-called water wars.

Table 6.1 Ten pathways and corresponding confidence levels, context and scale

Pathway	Confidence	Context	Scale
Water as weapon or strategic tool/measure can be used in situations of conflict, possibly intensified by water stress	Robust evidence High agreement	Existing conflict, food/water scarcity High vulnerability of vital infrastructure	Local–regional
Local water stress (droughts, economic scarcity, inaccessibility) may induce or intensify conflict over remaining water and food in fragile contexts	Robust evidence Medium agreement	Economically and politically deprived populations High dependence on rainfall Environmental mismanagement Existing tension/grievances between communities	Local
Food price spikes because of water-related disasters may accelerate or instigate local/regional riots increasing conflict risk	Robust evidence Medium agreement	Economically deprived populations, high percentage of income spend on food Misuse of power by elite factions Existing grievances against elites or the state Political instability	Local – global relations
The construction of mega dams may lead to tension between countries in a context of power struggles and shortages due to overexploitation	Robust evidence Medium agreement	Existing grievances and distrust between countries Rapidly developing projects Rapid political changes Little institutional capacity	Transboundary
A melting Arctic may change regional geopolitical relations and cause tension or conflict between countries	Robust evidence Medium agreement	Existing grievances and distrust between countries Conflicting national interests Little communication and openness	International
Variability in rainfall may influence the outbreak of local conflict and type of conflict in regions dependent on rainfall—increasing variability may lead to increasing levels of societal disruption	Medium evidence Low agreement	Direct dependence on rainfall for agriculture and cattle raiding Existing historical tension over land and water rights	Local–regional

A shortage of fertile land Resulting from land degradation & water stress (droughts, economic scarcity and inaccessibility) may induce local conflicts over the remaining fertile land, not necessarily at the same time or location	Medium evidence Low agreement	Deprived populations High dependence on rainfall Absent or unequal land policies - Misuse of power by elite factions Existing tension between communities or international investors Incoming migration and population pressure	Local-regional
Migration and forced displacement May increase as a result of water-related disasters, possibly causing tension or even conflict in receiving areas	Medium evidence Low agreement	Demographic composition of originating and receiving areas Economically and politically deprived populations, food insecurity Existing conflict in receiving and/or originating areas Networks Political freedom	Local-international
Economic shocks as a result of natural disasters can increase inequality adding to social disruption and grievances, increasing conflict risks	Medium evidence Low agreement	Low adaptive capacity, current grievances, unfair distribution of aid (increasing grievances), poverty trap	Local-regional
Water resources or water reservoirs can be pursued by nations or terrorist/rebel groups Under conditions of water stress	Limited evidence Medium agreement	Existing tension between nations, suppression, (perceived) water stress, history of conflict	International

### ***Contextual dependence of water-related conflict***

Further intensified water challenges, mainly as a result of too little water, may impact political stability on local and international scale, or may even affect conflict risk. In most parts of the world though, climate and water conditions do not constitute a threat for peace. Main context variables found in the discussed pathways are: high social and economic inequalities and poverty, high dependence on water for livelihoods, unequal policies related to the distribution of resources, grievances between communities or countries, and, most important, the quality of governance and institutions. Regions facing a combination of these characteristics are the regions where water insecurities can constitute security risks. Cause and effects relations will remain blurry though, since water insecurities can lead to cascading effects in the economic, social and political domain, but processes may also go the other way around, for example economic processes affecting water security. Vulnerable and fragile regions have little capacities to recover from the impacts of water insecurities. On national and transboundary levels, rapid or sudden changes in the physical world—often being the construction of dams—in combination with distrust between actors (mainly countries), grievances and little institutional capacity, increase risks as a result of water insecurities. Geopolitical relations can change due to climate change and the construction of infrastructure, affecting political relations and thus possibly increasing conflict risk.

Overcoming the different views and leaving out the rather undisputed water as weapon situations, the processes observed in the water and conflict linkages can be generalised, especially when water is considered as an indirect, contextual cause of conflict. Building on our analysis we find that water-related conflict risk is especially characterised by the:

- absence of stable institutions and an effective government, often conceptualised by good governance;



- deepening of poverty, lowering thresholds for individuals to engage in developing unrest/insurgency, since there is less to lose;
- deepening of inequalities between both people and nations, fuelling feelings of grievances;
- acceleration of changing power relations on all geographical scales as a result of increased inequalities;
- unequal distribution of remaining resources or aid resources, which may lead to increasing competition under conditions of scarcity or grievances.

### ***Final remark***

The discussion in the academic world on climate, water and conflict relations is still ongoing, including conflicting definitions and results. There is no simple relations between nature and society; they shape and reshape each other in multiple, context-specific ways. While this debate will continue, climate change and human-made water insecurities are already affecting societies. Acknowledging the complicated relation, and the vulnerability of those living in fragile regions, underlines the importance of achieving the SDGs while being aware of their interrelatedness. Rather than framing climate change and water availability as a military security issue, it should be primarily addressed as a human security issue that should be addressed in development and environmental policies. Including conflict-sensitive approaches, addressing the potential conflict risks, in climate mitigation and adaptation policies and development programmes may be a window of opportunity in fragile regions.

# Annex 1 Projections of environmental and socio-economic trends

This annex briefly elaborates on current and future socio-economic and environmental conditions. Understanding which areas may be facing increasing conflict risk due to decreasing environmental conditions requires an understanding of what regions face climate change and vulnerability challenges. Future weather conditions are projected to shift, increasing the likelihood of extreme weather conditions (Figure B).

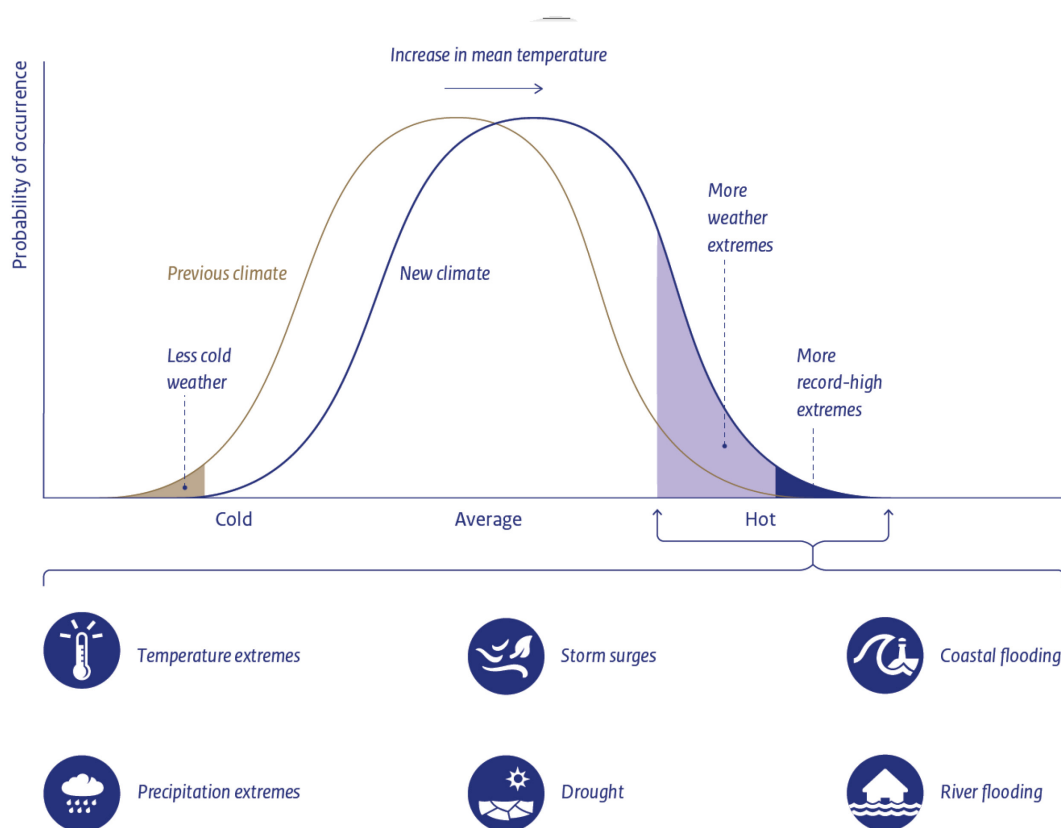
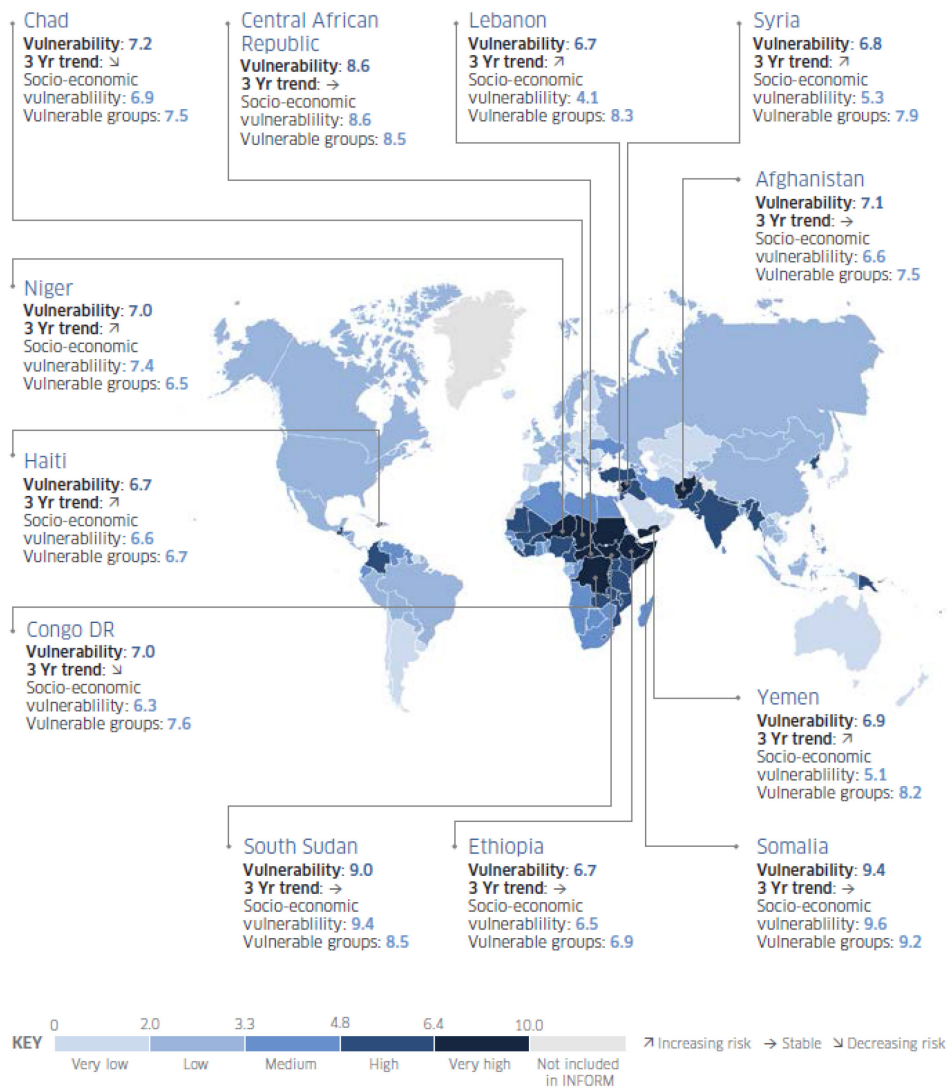


Figure B Change in averages and extremes due to climate change (PBL, 2018)

Map A displays the overall vulnerability per country nowadays, as defined by the Index for Risk Management (INFORM), based on the susceptibility of people to harm from exposure of stresses associated with environmental or social change, and the impotence to adapt to these potential hazards (Adger, 2006). Especially countries in central and north-east Africa and southern Asia are perceived to be vulnerable.



Map A Vulnerability per country based on socio-economic vulnerability (development and deprivation, inequality and aid dependency) and vulnerable groups (uprooted people and other vulnerable groups) (INFORM 2017)

Figure C gives an overview of people affected and killed and the level of economic damage. In general, inadequate water and sanitation is killing far more people than drought, flooding, earthquakes and epidemics and conflicts together. Flooding on the other hand, affects most people and causes most economic damages, as far as the data is available.

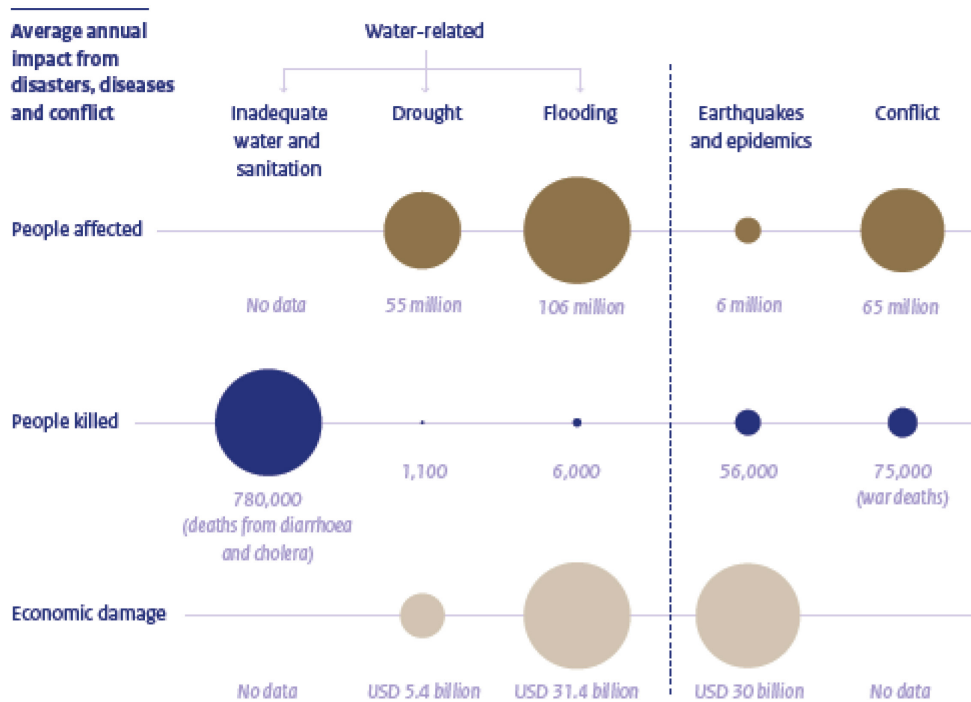
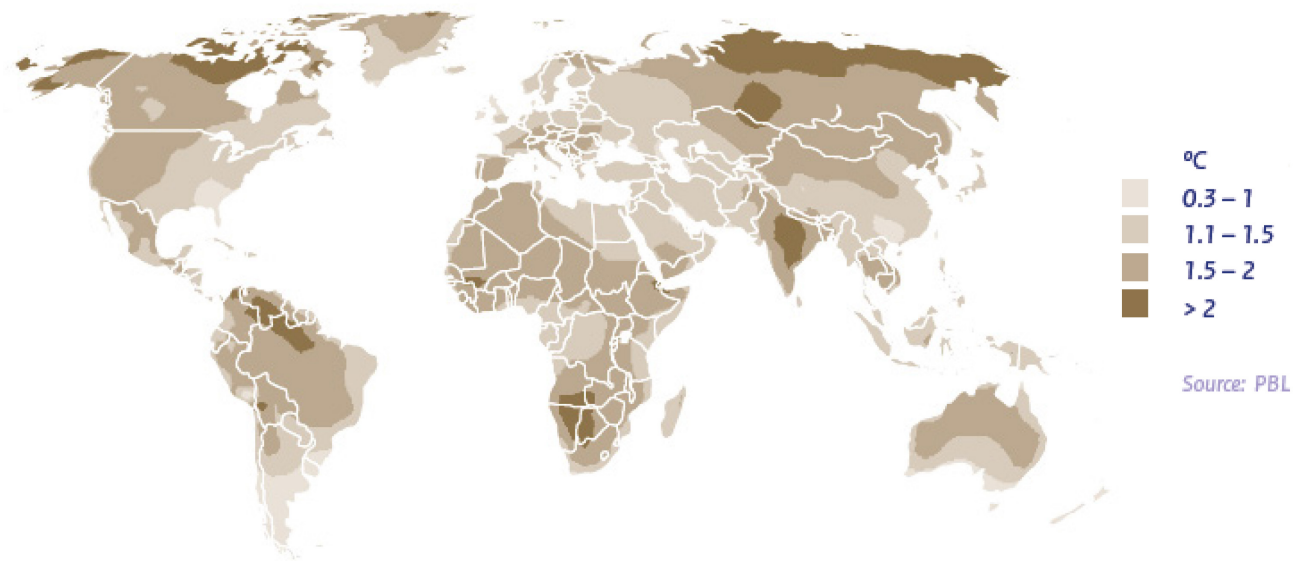


Figure C Average annual global impact from disasters, diseases and conflict (PBL, 2018)

## Environmental conditions

### Temperature, ice cover and sea level

Observed changes in weather patterns can be attributed to a warming climate system, a result of rising concentrations of greenhouse gasses due to human activities (IPCC, 2013). Globally, atmosphere and oceans have warmed compared to pre-industrial levels, amounts of snow and ice have diminished and average sea level rise is projected to accelerate (IPCC, 2013). Temperature rise due to man-made global warming is projected to be between 1.5° and 2.5° in 2050 (map B), and between 2° and 5° in 2100 (IPCC 2013).



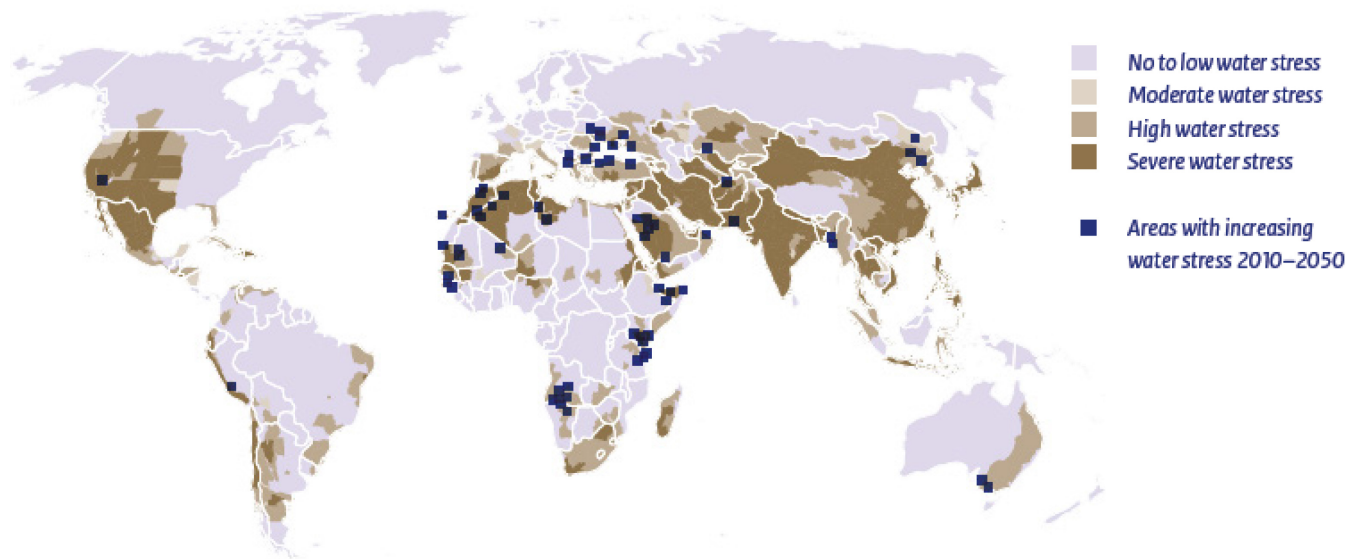
Map B Change in temperature 2010-2050 under a business as usual scenario (PBL, 2018)

Future sea level rise because of thermal expansion of oceans, and ice cap and glacier melting will pose several pressures to human security. Around 150 million people would be directly at risk when the sea level would rise with 1 meter (PBL, 2018). Although not yet assessed on a global scale, salinity intrusion, land loss due to coastal erosion, and forced migration will be major impacts of a rising sea level (Wong et al., 2014). But since migration to coastal regions is expected to continue the coming decades, the implementation of adaptation measures will be increasingly costly (Wong et al., 2014). This means that several locations will face increasing exposure due to the results of coastal migration, facing growing levels of industrialisation and urbanisation. In many coastal areas though, land subsidence exceeds absolute sea-level rise because of ground water extraction and urban development.

### Water quantity: droughts, shortage and consumption

In several places around the world, water stress will become more pressing than today. Water stress, in terms of absolute scarcity or inaccessibility may affect conflict risk by increasing competition or grievances over distributed water. Today, about 1.6 billion people live in countries with physical water scarcity; in 2050, this number may double (World Bank Group, 2016). This increase is projected to result from an increasing number of regional droughts, depletion of groundwater and increasing demand due to economic development and population growth.

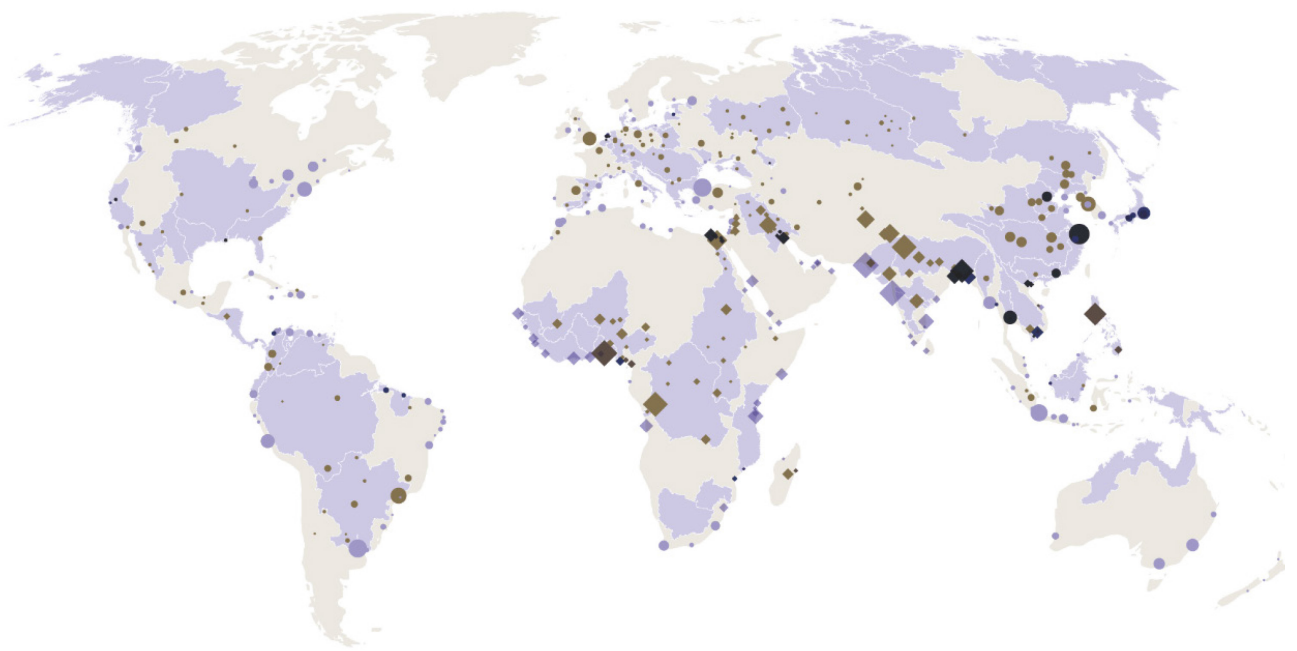
To meet the global increasing demand, vast regions will continue to use groundwater. This will most probably lead to the future depletion of aquifers. Combining the different pressures - economic development, population growth, the depletion of aquifers and changing aridity - map C shows regions that may face water stress in 2050. The main regions facing water scarcity are found in Asia, and the MENA.



Map C Water stress in 2050. Blue squares indicate where water stress is projected to increase (PBL 2018).

## Flooding

Flooding is the most frequently occurring natural disaster, around the world. Currently, 76.9% of the people exposed to flooding live in Asia (Pesaresi et al., 2017). This is also projected to be the main region that, in the future, will be exposed not only to flooding, but also to cyclones. This is partly due to high vulnerability and partly due to disproportionate large and continuously increasing populations (exposure) in among other countries India and China. Map B shows global exposure of mayor cities to flooding; the difference in this map is mainly due to population growth. In low and middle-income countries, people will be impacted most, both in short and long-term perspective. For them, health and education are at a greater risk as a result of natural disasters and more time may be needed to recover because they cannot rely on savings to recover (Hallegatte et al., 2017). Economic shocks because of flooding, therefore, influence economic inequality.



#### Rapidly growing delta, coastal and river cities

- ◆ Rapidly growing delta city
- ◆ Rapidly growing coastal city
- ◆ Rapidly growing river city
- Delta city
- Coastal city
- River city
- Delta river basin



Diameter = relative size of urban population

Source: PBL

Map C Cities at risk due to flooding in 2050 (PBL 2018).

### Water quality: health and sanitation

Water of sufficient quality is not only essential for human health, but also for social and economic matters, and the quality of ecosystems. Agriculture, industry and households are main users and polluters on a global scale. Climate change may add to water quality issues via increasing water temperatures, droughts and flooding, affecting ecosystems and human health. On the long or short term, water quality issues are a threat for water quantity, health and sanitation, and economic activities such as food and energy production and fisheries.

Today, 12% of the world population has no access to clean drinking water and almost one third does not have basic sanitation facilities (PBL, 2018). Figure C shows the present situation regarding safe drinking water and basic sanitation for five regions. Water quality issues increase the risk on the outbreak of waterborne diseases due to contaminated water whereas the physical impacts of extreme weather events may result in the destruction of assets to control water quality, finally leading to diarrheal diseases. Indirect effects may be health threats due to (forced) migration, decreasing food security leading to malnutrition and increasing poverty because of a diminishing capacity to work, again leading to decreased access to health care and sanitation.

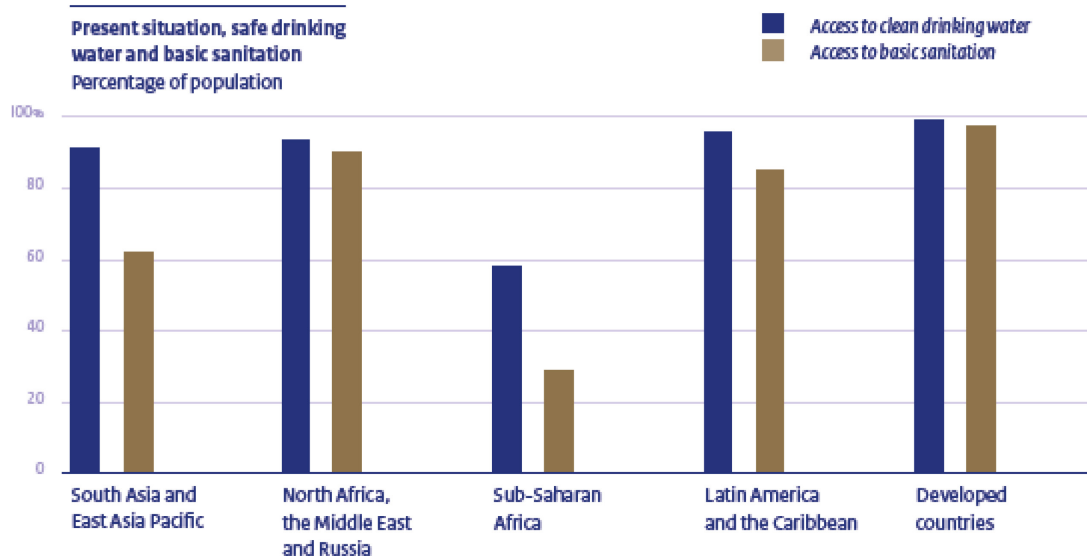


Figure D Access to safe drinking water and improved sanitation per world region (PBL 2018).

The World Bank regards health and sanitation issues as a primary reason why people fall (back) into poverty, as a result of expenses, loss of income and long-term consequences (Hallegatte et al., 2016). These issues are not all caused by water quality issues though; health impacts can also result from food insecurity, the sudden onsets of natural disasters or increased vulnerability when people are migrating. The access to water and improved sanitation relate to the quality of governance in a country because the development of water infrastructure and distribution needs an organised form of coordination and resources.

## Food

Food security depends on sufficient production, the way food is distributed and the ability of people to obtain food. Food security<sup>21</sup> is closely related to governance (Figure G), since governance structures influence modes of production, trade and distribution mechanisms, food prices, and the capacity development of people (C. Hendrix and Brinkman, 2013). Food production may be affected heterogeneously around the world by a range of impacts due to drivers related to increased levels of greenhouse gasses: temperature extremes, droughts, flooding and storms, salt intrusion due to sea level rise, and ocean acidification (Porter et al., 2014). Map D shows regions that are projected to face yield gaps in 2050 in irrigated and non-irrigated regions.

<sup>21</sup> Definition of food security: Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices (UN 1975)



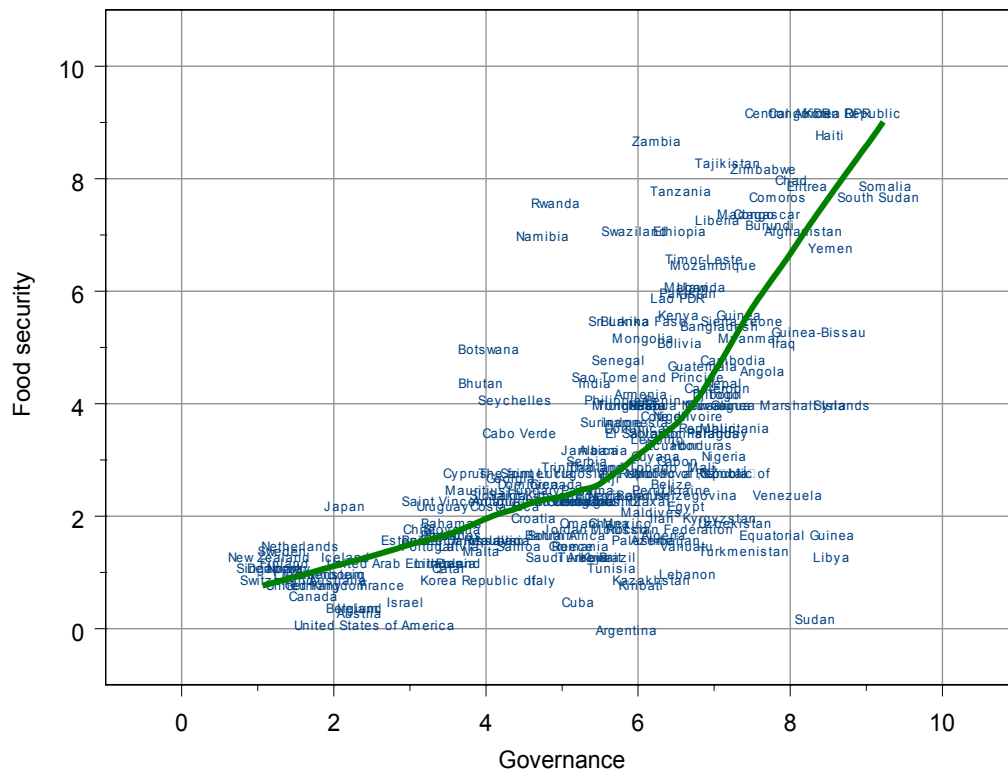
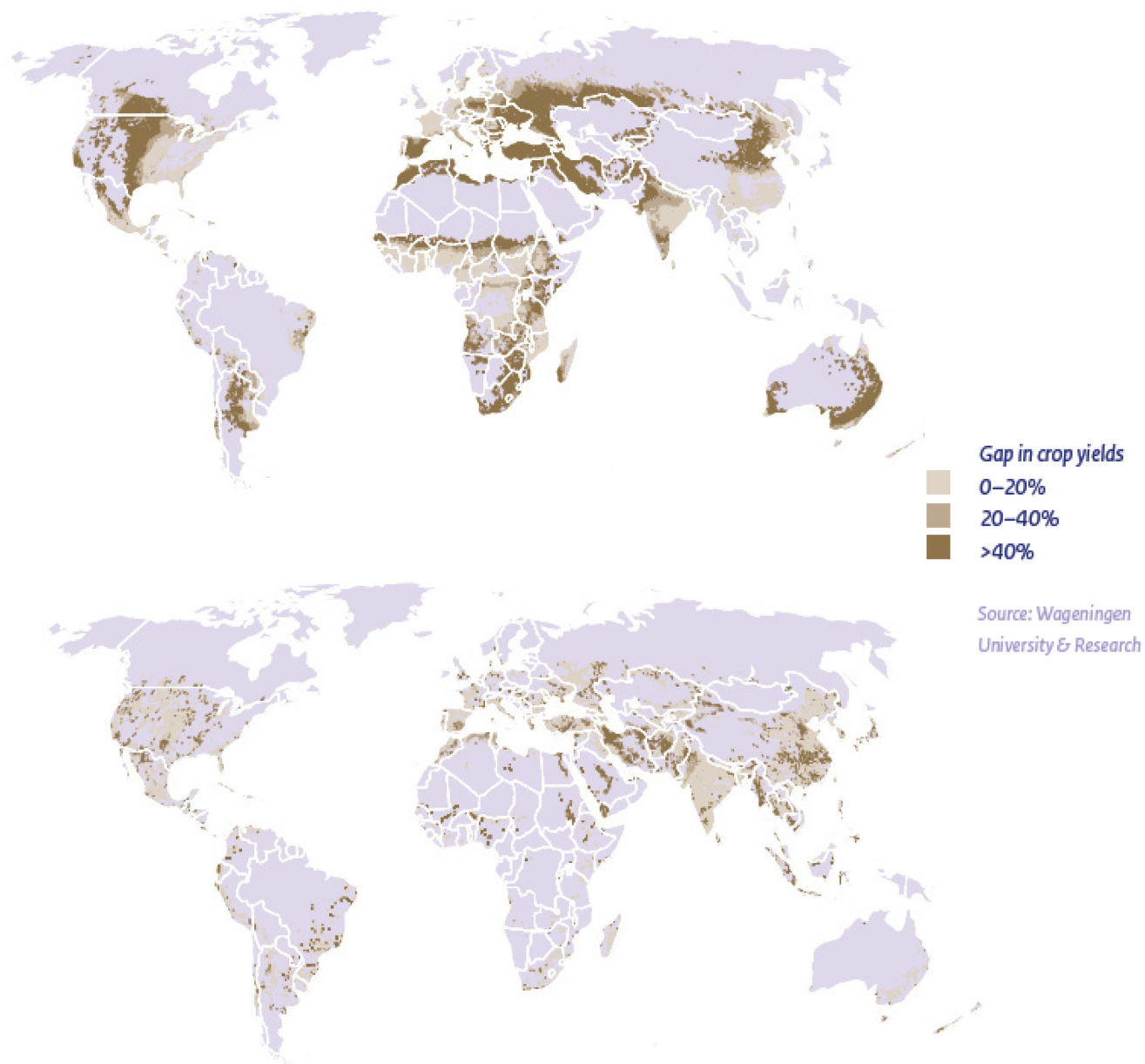


Figure E Food security and governance relations (Visser & De Bruin, 2018). The lower the value the better the food security/governance level.

Demand for agricultural products is projected to increase by 50% in 2030, which will most likely lead to further intensification of the global food system (Wheeler and Von Braun, 2013). And although food production is projected to keep on rising, food provision for the poorest people may increasingly be under threat as a result of decreasing individual and household incomes (Wheeler and Von Braun, 2013). The relative spending of poor people is higher compared to richer people, emphasising the vulnerability of the poorest people when food prices rise (World Bank Group 2016). Food price shocks as a result of decreased agricultural production can also reduce already poor people’s consumption or possibilities to save assets, pushing them further into poverty (Hallegatte et al., 2016). Food prices are largely driven by investor speculations on the world market and the production of ethanol out of corn (Lagi, Bertrand, and Bar-Yam, 2011).



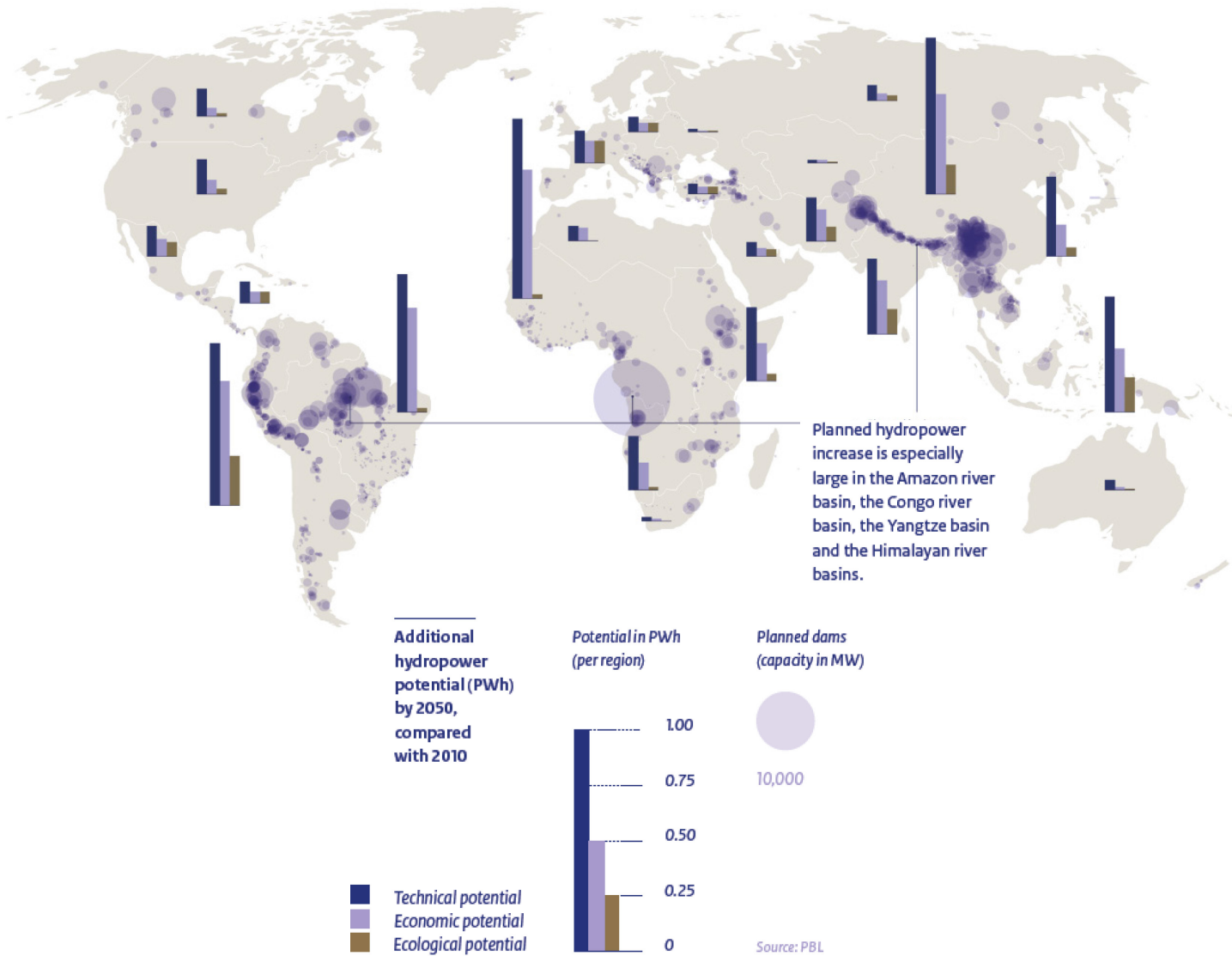
Map D Map above: Water yield gap for rain fed agriculture under a business as usual scenario in 2050. Map below: water yield gap for irrigated agriculture under a business as usual scenario in 2050 (PBL, 2018).

## Energy

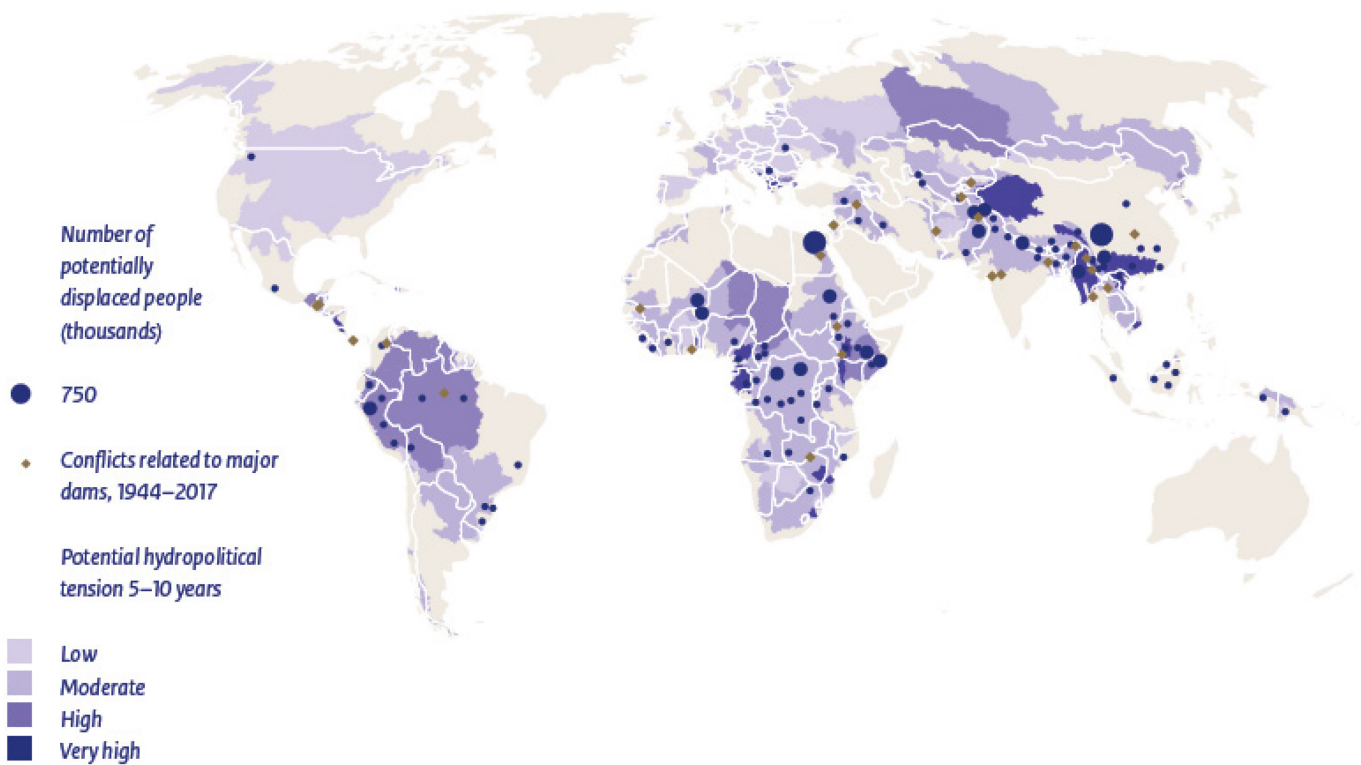
Water and energy are inextricably linked, since water is needed for energy production, and energy is often needed for water treatment and distribution, and both are linked to economic development. In 2015, 1.2 billion people did not have access to energy and 2.7 billion people relied on traditional biomass energy production (EIA, 2016). Global energy production will keep on growing; current projections show an increase of around 28% between now and 2040 (EIA, 2017). The production of biomass for energy production often competes with food production where the production of hydroelectric power affects ecological quality (Popp, 2014; Zarfl, 2015).

Map E shows the regions where the potential for hydropower is high. Especially southern Africa and South America show a large amount of potential for hydropower, indicating that in regions with water security issues, the production of energy out of hydropower may cause tension over the use of resources. Map F gives an overview of basins at risk due to little

institutional capacity in basins and the potential development of large infrastructure, mainly hydropower dams.



Map E Additional hydropower potential (PWh) by 2050 compared with 2010 (PBL 2018).



Map F Pressures in river basins related to dam construction (PBL 2018)

## Socio-economic variables

### Demographics

The world population will continue to grow: its magnitude is uncertain though (Figure F). Population growth can be a risk factor for water insecurity in terms of increasing demand and an increasing number of people at risk. Population growth can be a risk factor for environmental degradation, and political instability, especially in countries struggling with poverty and unemployment. In an often-used trend scenario, the global population is projected to increase to 9 billion in 2050. Major population growth is projected for Africa and the Middle East, regions that are already facing high levels of vulnerability, and mega cities will increasingly grow in these regions, together with cities in Southeast Asia and Latin America. As urbanisation continues, the number of hotspots for food, electricity, and water consumption will increase as well.

### Global GDP

Today's and future economic development and distribution of welfare will influence to what extent people and governments will be able to react and adapt to natural disasters. Whereas the global GDP is projected to continue to grow (Figure F), there will be numerous, mostly already poor countries that will stay behind in their economic development. Since resilience is linked to the amount of money available, these economically less developed countries are expected to stay behind in making their regions resilient to water security threats.

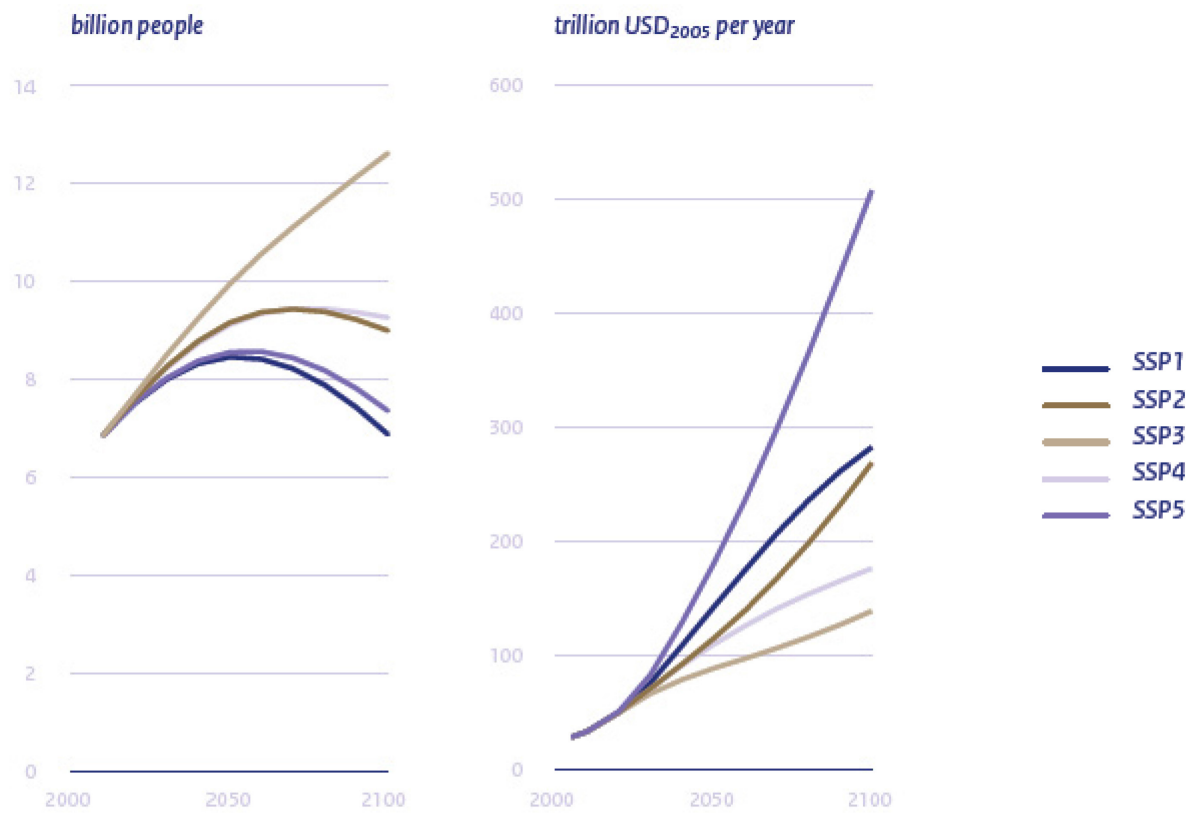


Figure F Left: global population growth under different scenario's. Right: Global GDP growth under different scenario's (PBL 2018).

# Annex 2 Conflict status in the world

In recent years, the world has become slightly more violent in absolute terms, due to a small number of highly violent conflicts (Figure G), such as the conflict in Syria, increasing the absolute number of refugees (UNHRC, 2015). Neighbouring conflict and a history of conflict are risk factors for future conflict and instability, and therefore determine regions in conflict today (De Stefano et al., 2017; Peters and Budimir, 2016). There may also be an increase in local vulnerability to natural disasters and poverty, which may lead to a growing number of migrants and refugees (Peters and Budimir, 2016; UCPD 2017). Since the definition of conflict differs per institute and study, the conflict status in the world differs according different institutes. Map G shows the state of conflict (upper), the state of peace (lower), and the fragile state index<sup>22</sup> (middle), for 2016.

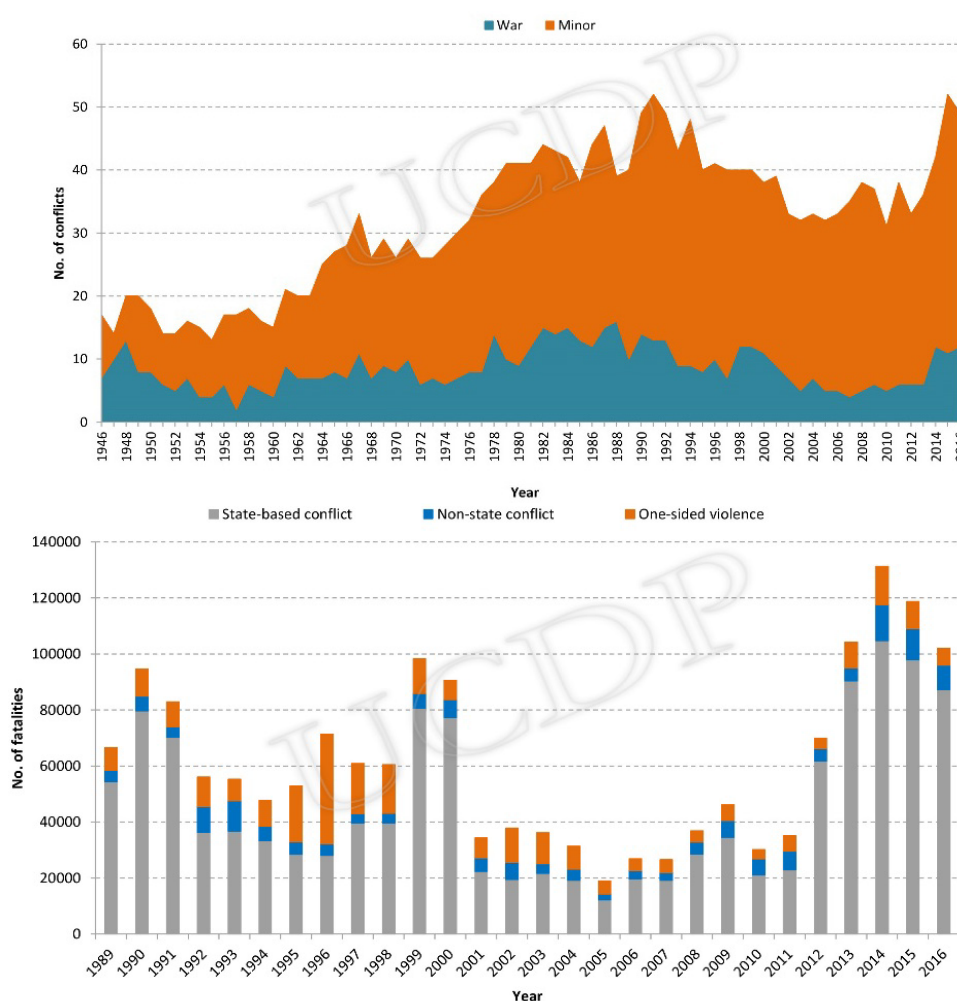
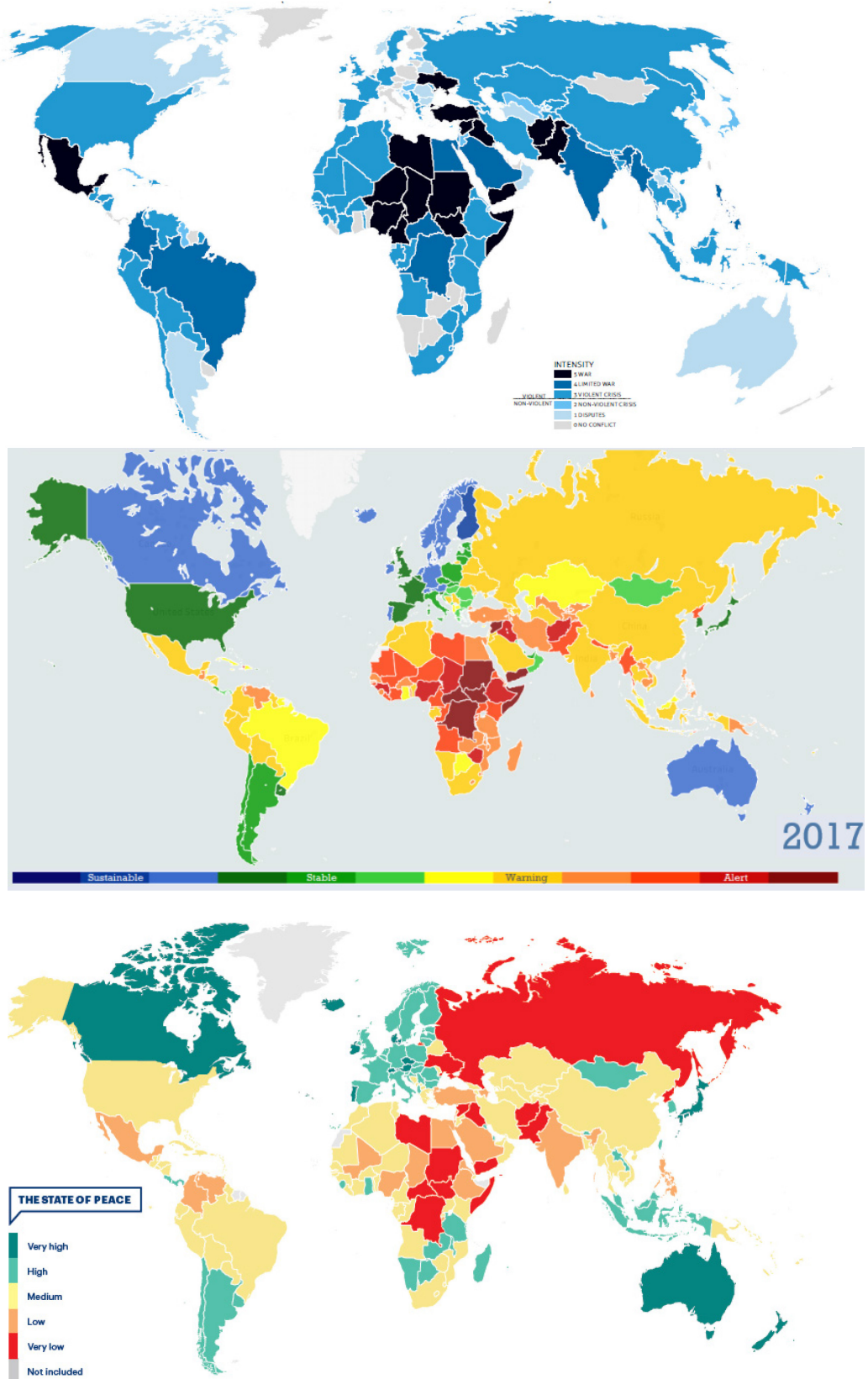


Figure G Top: Number of state-based conflicts since 1946 as counted by the Upsala Conflict Data Programme (UCDP). Below: Fatalities by type of violence (excluding Rwanda 1994) 1989-2016 (Allanson et al., 2017).

<sup>22</sup> The fragile state index is based on a conflict assessment framework for assessing the vulnerability of a state to collapse, based on twelve conflict risk indicators.

All maps show the countries, Syria, Sudan, Yemen and Somalia as the countries with the highest level of conflict. However, there are numerous countries, such as Russia, Bangladesh and Mexico, which are classified differently on the different maps. This is because the institutions that define the state of conflict use other indicators and scales, and other definitions for conflict.



Map G Three maps presenting conflict levels per country in different ways. Top: Conflict barometer in six categories (HIK 2016). Middle: Fragile States Index 2017 in twelve categories (The Fund for Peace 2017). Bottom: Global Peace Index 2017 in five categories (Vision of Humanity 2017).

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