PBL Netherlands Environmental Assessment Agency

Sophie de Bruin, Joost Knoop and Willem Ligtvoet (PBL Netherlands Environmental Assessment Agency); Louise van Schaik and Ernst Kuneman (Clingendael Institute); and Karen Meijer (Deltares)

Acknowledgements

We are most thankful to Aaron T. Wolf (Oregon State University), Rebecca Opitz-Stapleton, Rebecca Nadin (Overseas Development Institute) and Jonas Vestby (Peace Research Institute Oslo) for their review of this document, and to Wilfried ten Brinke (Blueland Consultancy) for his useful suggestions.

Water, Migration and Conflict

Scientific justification of the information produced for the chapter 'Water, migration and conflict' of 'The Geography of future Water Challenges' (2018), The Hague: PBL Netherlands Environmental Assessment Agency.

pbl.nl/future-water-challenges

Main messages

- It is globally acknowledged that water-related disasters and gradually increasing water stress can impact human security, in several ways. Economic shocks resulting from such disasters and gradually changing environmental conditions both particularly affect poor people, and may contribute to dynamics that result in poverty and further economic inequality. The link between climate-related and socio-economic water issues and migration or conflict, however, is less clear and academically contested.
- Climate, water and conflict research is challenging, as it involves multiple disciplines with various focus areas. In the field of conflict research, some scholars emphasise not to overdramatise the relationship between those areas, while others contest even the existence of a causal relationship. There are challenges and data gaps depending on the indicators used for climate change, conflict, level of analysis (national versus provincial level) and time scale (historical data versus predictions of the future).
- Due to the complexity in conflict research, prediction is a slippery slope, and more research is needed on the possible mechanisms underlying water-related geopolitical tensions.
- Since 2008, on average, an annual 21.5 million people have been displaced by storms and flooding. After internal displacement, people mostly return to rebuild their area.
- However, migration influenced by slow changing processes, such as increasing water stress, soil degradation and salinisation, is difficult to measure. The reasons for migration depend on a range of circumstances, with economic and demographic factors having a major influence, as well as individual networks. Changes in water availability especially affect labour opportunities in countries that largely depend on agriculture for their GDP. In economically less-developed countries, more people are employed in the agricultural sector and, thus,

water-related issues have a greater impact on people's decision to migrate. For the future, these adverse effects are projected to have an impact, predominantly in Sub-Saharan Africa and Southwest Asia.

- Water stress might also play a role in intrastate conflicts, but when it does, it will always be in combination with a range of other factors, depending on context. However, countries with a low GDP and ineffective government institutes are most at risk. Water stress may have an indirect impact on conflict risk via decreasing economic opportunities, increasing inequality or decreasing governance effectiveness. As with migration, these potentially adverse effects are expected to also predominantly affect Sub-Saharan Africa and in Southwest Asia.
- Sharing of water in international river basins is settled peacefully, most of the time, yet the construction of hydropower dams might raise tension between riparian countries, especially when treaties are absent or not operating efficiently due to an uncooperative attitude by the countries involved. This may particularly occur in South America, Africa and large parts of Asia. Local struggles or even the risk of conflict may increase when huge numbers of people are displaced as a result of dam construction. These types of conflicts may increase, particularly, in regions of South America, Africa and Southeast Asia.

Content

1 Introduction

Water plays a critical role in social and economic progress, on global, national, regional and local levels. Sufficient and clean water is a precondition for development, and water-related projects are often stimulating cooperation between countries, communities or individuals (Whittington, Wu et al., 2005; Wolf, 2007; Brochmann and Gleditsch, 2012). However, a combination of projected population growth, economic development and climate change may increase water-related risks for sustainable livelihoods, and in more exceptional cases for migration and political stability (Adger, Pulhin et al., 2014).

Attention from political, social and academic institutes for climate, water and migration and/or conflict has been increasing, in the past decade. Studies include alarmist reports, projecting mass migration and violent conflict due to droughts and resource scarcity, the conclusions of which often resonate in the media, as well as more nuanced case studies pointing to contextual factors, such as conflict history, inequality and demographics, as the driving force of—future—tension and conflict (Al Jazeera, 2012; Gleditsch, 2012; Selby and Hoffmann, 2012; Buhaug, Nordkvelle et al., 2014; The Guardian, 2016; Defence Intelligence Agency, 2012). There are also researchers who point to water, as a conversation starter; water-related issues could be a starting point for cooperation between countries, in terms of river basin treaties, because of shared interests and possibilities for improved understanding (Wolf, 2007; Zeitoun and Mirumachi, 2008; Link, Scheffran et al., 2016).

This document assesses the links between water-related issues and migration or conflict risk. Water-related issues are the topics discussed in the infographics book, *The geography of future water challenges* (PBL, 2018), which include water quality, flooding, droughts and food, ecology and energy (Figure 1.1). Based on the findings from literature studies, hotspot maps were made, analysing:

- migration and displacement linked to water stress and sea level rise;
- local conflict risk associated with water stress;
- hydropolitical tension in river basins and the potential number of people displaced due to hydropower dam construction.

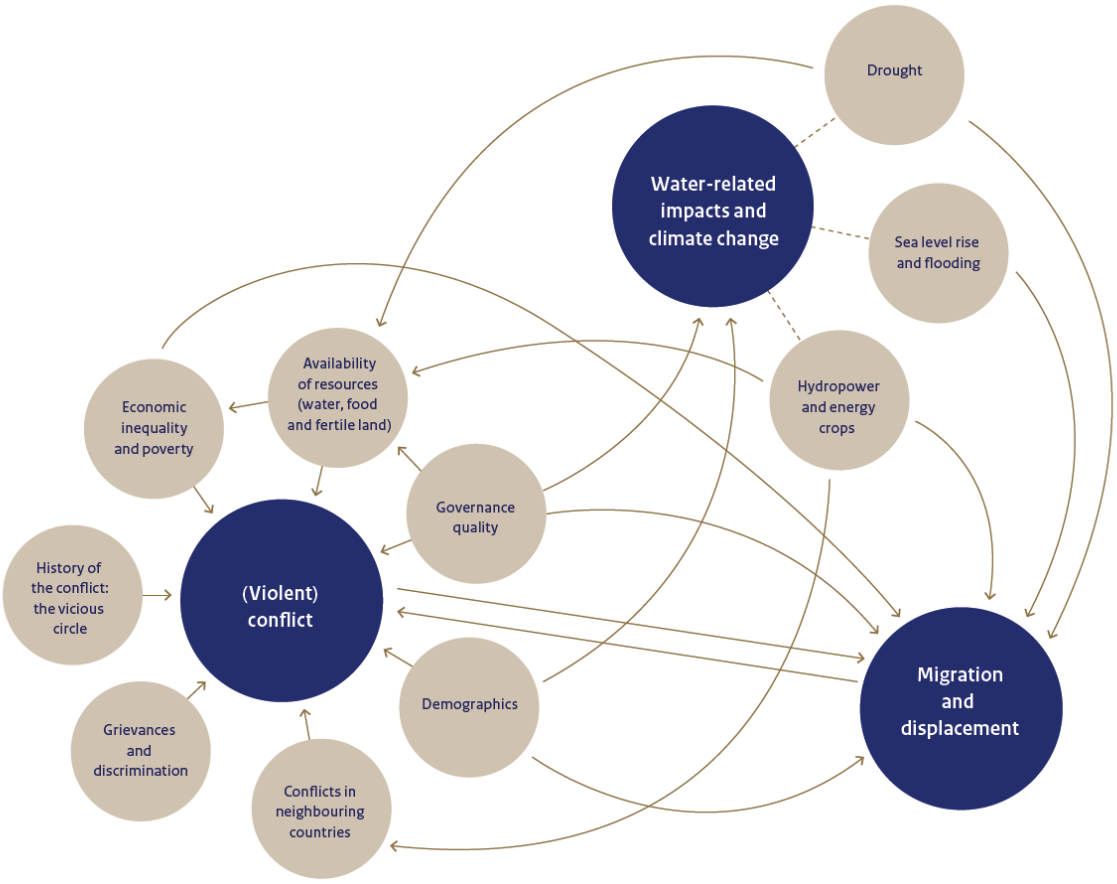


Figure 1.1 Conceptual figure displaying the relationships between water-related impacts and climate change, migration and—sometimes violent—conflict

1.1 Setting the scene

Displacement, migration and adaptation

Between 2008 and 2015, an average 21.5 million people per year were displaced by weather-related events, mainly due to flooding and storms (IDMC, 2016). The people who migrate as a result of drought or slow-onset processes, such as land degradation, are not included in this number, since it is hard to trace migration back to a single cause. The impact of environmental change is often just one of the forces that drive the movement of people; other include demographic, social, political and economic conditions, either in the receiving areas or in the region of origin, in combination with people's personal networks (Black, Adger et al., 2011). However, some scholars see clear links in areas where people directly depend on their physical environment (Reuveny, 2007; Warnecke, Tänzler et al., 2010) , where others suggest that too much weight is awarded to environmental drivers of migration (Selby and Hoffmann, 2012; Brzoska and Fröhlich, 2016). In any case, independent of the importance of the potential factors, migration can be seen as the result of so-called push-and-pull factors (Figure 1.2). Moreover, migration can be either temporary or long term and even become permanent. In particular, with respect to changing environmental conditions, cyclical or temporary migration is often the natural way for people to adapt (Stapleton, Nadin et al., 2017). Finally, data on migration—particularly internal migration—not caused by natural disaster are scarce and rarely linked to specific causes.

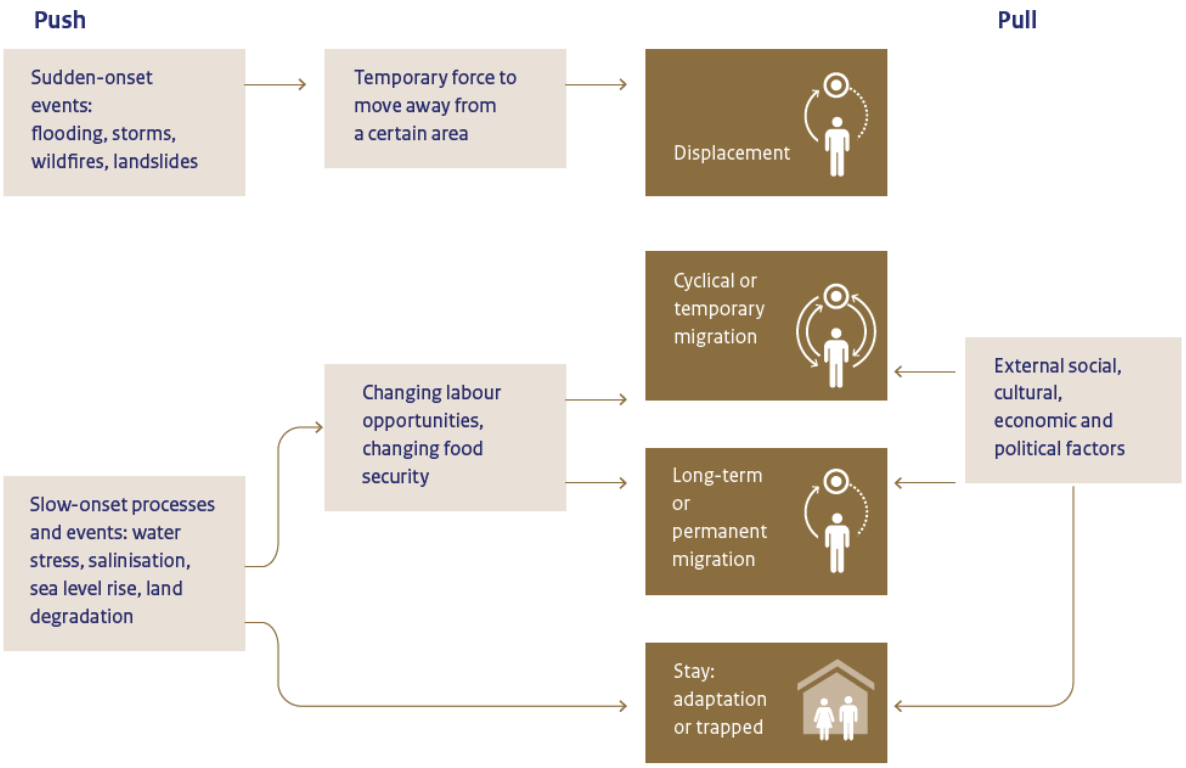


Figure 1.2 Conceptual figure explaining the different forms of migration, in the context of sudden-onset and slow-onset events.

Collaboration and conflict risk

The relationship between water and conflict is also contested, although the main drivers of conflict can be linked to water in various ways and on different scales (De Bruin, Knoop et al. 2018). Since water-related issues are not assumed to be the sole cause of conflict, analysis of indirect effects via adverse economic and livelihood impacts is important (Buhaug, 2016). The most direct causes are the intensification of poverty and economic inequality. Especially when events occur in combination or successively, people who are already poor are likely to be pushed further into poverty (Olsson, Opondo et al., 2014; Hallegatte, Bangalore et al., 2016). Water-related impacts are threat multipliers for poverty according to the IPCC, most often intertwined with other societal processes (Olsson, Opondo et al., 2014). Main causes include price shocks, which reduce poor people's consumptions levels, loss of assets due to natural disasters, and health shocks (Hallegatte, Bangalore et al., 2016). The World Bank has estimated that climate change could push an additional 100 million people or more into poverty by 2030—around half of them for reasons attributed to droughts, unequally divided across the world (Hallegatte, Bangalore et al., 2016).

1.2 Goal of this publication

The main goals for this part of the project are to:

- gain insight into how too little, too much and too dirty water may affect migration and political conflict risk via case studies, literature study and quantitative analysis;
- gain insight into the academic debate on the relationship between water, migration and conflict risk;

- identify water-related hotspots around the globe with respect to migration and political and other conflict risks;
- present knowledge relevant for policy and further research; about what is needed to include the knowledge about water–conflict relationship into policy decisions and bring it into practice.

1.3 Relevance of this research/limiting conditions

The following aspects explain why it is difficult, but also necessary to combine water/climate and conflict analyses:

- Many security analysts (e.g. political scientists) are sceptical about the existence of a causal relationship between climate and conflict, and a large share of them argue you can only explain the emergence of conflict by looking at the specific political–economy setting in which they emerged, in which also the history of conflict is taken into account. These analysts and researchers tend to doubt the possibility of forecasting conflict. A lot of academic debate centres on questions towards the factors that increase conflict risk, and how these factors interrelate. Nevertheless, some data-based early warning mechanisms, such as EU INFORM, have been developed. Often data analysis is supplemented by confidential analysis of intelligence agencies and Embassies.
- The link with security can be used or misused for specific political agendas (e.g. Assad claiming the Syria revolts being caused by climate change and not by his repression). Both water challenges and conflicts result from many, often governance-related, factors; there are many potentially spurious relationships and the weighing of various contributing factors is difficult.
- Data sets on conflict and climate-related water availability are difficult to combine, due to differences in geographical and temporal scale/resolution, uncertainties with regard to the time-lapse relationship between conflict and water and differences in the used definitions of conflict and in the environmental variables used.
- Projections on climate change and water-related issues are available for a longer term (e.g. 2050). However, the models these projections are based on, know large variation in outcomes resulting from variations in climate (reference concentration pathways (RCPs)) and socio-economic (shared socio-economic pathways (SSPs)) scenarios, and limitations of the models themselves. Thereby are not all data of importance available. It is for example difficult to project whether/how inequality or governance effectiveness will change in the future. Many of the big political events of the past (e.g. the fall of the Berlin Wall and the Arab Spring) were not predicted.
- However, as a consequence of further population growth, economic development and climate change, future global water conditions seem to point in the direction of increased competition and water scarcity in certain regions, thus providing a more challenging environment. With the global population growing to 9 billion, it may be questioned to what extent historical patterns will be representative of the future. It may be plausible that increased competition and water stress become more important drivers of migration, human insecurity and conflict risks.
- Making statements on possible changes in migration patterns and conflict risks, in the long term, is a different matter. Human security implications of water-related events can be

approached using the knowledge about the relationship between them, but the situation is different for the subjects of conflict and migration. Violent conflict is an extreme result of multiple—sometimes endogenous—socio-economic, political and institutional factors whose trajectories are highly uncertain and difficult to predict. The same goes for the similarly complex process of migration, which is nowadays already hard to attribute to specific push or pull factors, let alone making credible projections of these factors. Taking into account the increasing 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).

2 Approach and methods

In the project, we used several methods to arrive at a credible method of hotspot mapping. In particular, the relationship between water and human security, migration and conflict risk has been unpacked by summarising the literature. Of particular relevance is the report on water and conflict pathways (De Bruin, Knoop et al. 2018), which systematically maps the literature on the links between the water issues as included in this project and geopolitics. The study assesses the level of confidence of each identified pathway, based on the degree of academic consensus (agreement) and the number of observations (evidence).

Relevant data sets have been analysed and used for the hotspot maps. In the course of the project, several sessions have been held to test intermediate conclusions and progress. These sessions have also been used to receive new ideas and case studies. For all water issues, we tried to make the link with geopolitics, discovering that for many of them, such as water quality, hardly any literature is available. Perhaps most importantly, we tested our result by presenting progress and our findings to experts and relevant audiences at international conferences. Sessions were organised at Adaptation Futures 2016; Planetary Security Conference 2016 and 2017; Changing Routes 2017 and the Stockholm Water Week 2017. Finally, the chapter on conflict and migration in the publication on *The geography of future water challenges*, together with this publication, were both reviewed by three external experts.[1]

The policy brief that was the result of the 2016 Planetary Security Conference is available online.

[1] Migration: Rebecca Nadin (ODI); Water stress and Conflict: Jonas Vestby (PRIO); Transboundary river basins and Conflict: Aaron T. Wolf (Oregon State University).

3 Main findings

3.1 Literature review

Several relationships between water-related issues, migration/displacement and tension/conflict were identified, on the basis of a literature study. Table 3.1 gives a general overview of the various relationships found between the water topics discussed in *The geography of future water challenges* and human security, displacement/migration and tension/conflict.

Table 3.1 Negative impacts of water-related events on human security, displacement/migration and conflict

Driver	Human security	Displacement/ migration	Tension/Conflict
Energy production – hydropower/ energy crops	Competition over agricultural land due to the cultivation of energy crops. Changing environmental conditions due to dam construction.	Displacement due to dam construction, environmentally motivated migration due to degrading environmental conditions	Local: protests and strikes due to dam construction, displacement of people; competition over agricultural land Transboundary: changing power relationships, causing tension or even conflict between riparian states over water in transboundary river basins
Water stress	Economic decline, poverty unemployment, shortages in food for human consumption, poor hygiene, competition over fertile land and water	Increasing push factors to encourage migration, especially within dryland areas, which increases seasonal migration and income diversification	Local: violent and non-violent competition over water and arable land Local/regional: In water-scarce and conflict-prone environments, water can be increasingly used as a weapon national and international: transboundary issues over water use or retaining water
Declining Food production	Economic decline and unemployment, poverty, undernourishment (stunting growth and causing vulnerability to diseases)	Economically motivated temporary and permanent migration (which diversifies income), due to food shortages and limited economic opportunities	Local: declining food production in conflict situations makes people more vulnerable Globally: food prices may increase due to global interrelatedness , triggering local riots in already tense societies
Water quality and sanitation Issues	Health and sanitation issues, high–predominantly infant– mortality rates, decreased productivity due to health issues and related expenses	May be a push factor to leave; but no case studies found.	No impact on conflict related to water quality and sanitation issues found
Ecological degradation	Declining ecosystem services, economic decline	Encourage temporary migration to cities or natural areas, to achieve income diversification	No clear impact on conflict related to ecological degradation found—apart from environmental groups protesting against, for example, mines.
Flooding	Casualties, economic shocks, poverty,	Temporary, internal displacement due to river and sea flooding; permanent displacement due to sea level rise	No clear relationship: economic shocks caused by flooding may result in increasing inequality, adding to social unrest in already conflict-prone areas. However, this notion is contested, although increasing cooperation has also proven to result from extreme events such as flooding.

Sources: Allouche, 2011; Black, Adger et al., 2011; Seto, 2011; Fjelde and von Uexkull, 2012; Wilby and Keenan, 2012; Adger, Pulhin et al., 2014; Devlin and Hendrix, 2014; Salehyan and Hendrix, 2014; Smith, 2014; von Uexkull, 2014; Buhaug, Benaminsen et al., 2015; Zarfl, Lumsdon et al., 2015; von Uexkull, Croicu et al., 2016; De Stefano, Petersen-Perlman et al., 2017.

3.2 Migration

A difference can be made between migrants and displaced people. Displaced people are those who are forced to move because of physical impacts as a result of, for example, flooding or storms, whereas migrants are people who move as a result of, among other things, slow-onset environmental degradation of their living environment. The linkage between gradually changing water conditions and migration, however, is a contested albeit often discussed relationship (Tacoli 2009, Burrows and Kinney 2016). Moreover, the separation between forced and voluntary migration 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. 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). There is no data on the number of people who return, or the number of those who seek a better future elsewhere. The people who migrate because of slow-onset events or processes, such as land degradation and salinisation, are not included in this number, since it is difficult to relate migration to a single cause. Often, slowly changing environmental circumstances are just one of the causes for people to move.

Migration is the result of various push-and-pull factors

Sometimes, people move to other locations, particularly to cities, to take advantage of the better opportunities there (e.g. education, employment), which can therefore be regarded as pull factors. On the other hand, people might temporarily or permanently migrate because of declining livelihood security, which could be regarded as a push factor. Figure 3.1 shows the numerous environmental, social, political economic and demographic drivers, which can be both macro- and micro-level push-and-pull factors. Individual characteristics, such as age and well-being, also influence people's individual decisions to migrate.

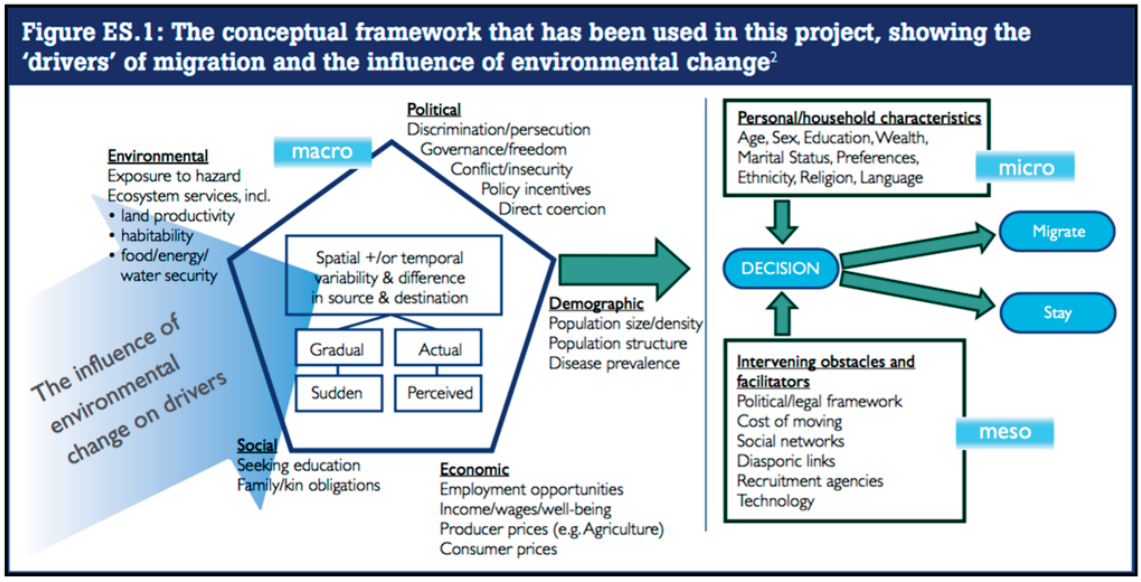


Figure 3.1 Conceptual framework showing the drivers of migration and the influence of environmental change, including factors on the macro, meso and micro level (Government Office for Science, 2011)

Environmental change as direct/indirect driver of migration

When their livelihoods are dependent on water, especially those of crop farming, livestock farming and certain industries, people may temporarily, cyclically or permanently migrate to areas with better economic opportunities (Ionesco, Mokhnacheva et al., 2017; Stapleton, Nadin et al., 2017). Increasing water scarcity, in such cases, has a major impact on migration (Neumann, Sietz et al., 2015). Long-term and/or recurrent drought affects livelihoods in areas where people have few

resources or lack the capacity for dealing with water stress. Environmental changes, mostly related to water, affect producer prices the most, and in that way also employment opportunities. Therefore, people living in countries where they depend on agriculture for their income are most impacted by environmental change. Migration related to water stress is likely to be more prevalent in countries where there are no proper governance structures to assist people affected by these changes.

Clingendael Policy Brief: Climate–migration–security: Making the most of a contested relationship (2017)
This policy brief expounds the academically contested relationship between climate change, migration and security. The study emphasises the lacking investments in 'countries of origin', since most existing policies are still focused on responding to voluntary and/or forced migration. No-regret policy options that boost youth employment, restore ecosystems, strengthen resource management and reduce inequalities between groups could be envisaged to improve local living conditions.

Demographics and urbanisation

Young adults are more likely to move than older people (Black, Kniveton et al., 2008); therefore, the number of migrants in a country is expected to be related to the number of young adults. Since the propensity to migrate is generally higher among younger people, countries with high population growth rates are expected to have relatively high and increasing numbers of migrants (Black, Bennett et al., 2011; Marchiori, Maystadt et al., 2012). Where population growth in parts of the global North is expected to decline, large parts of Asia and especially in the Sub-Saharan African drylands will continue to experience high levels of population growth rates and skewed demographic distributions, now and in the future (Figure 3.2). In recent decades, a sharp increase has been observed of migration from rural areas to urban areas, mostly in the same country. Urbanisation can be mainly attributed to perceived and actual economic and social pull factors from urban areas. Yet, to a lesser degree, this flow can still 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 subsidence), flooding and storms (Seto, 2011).

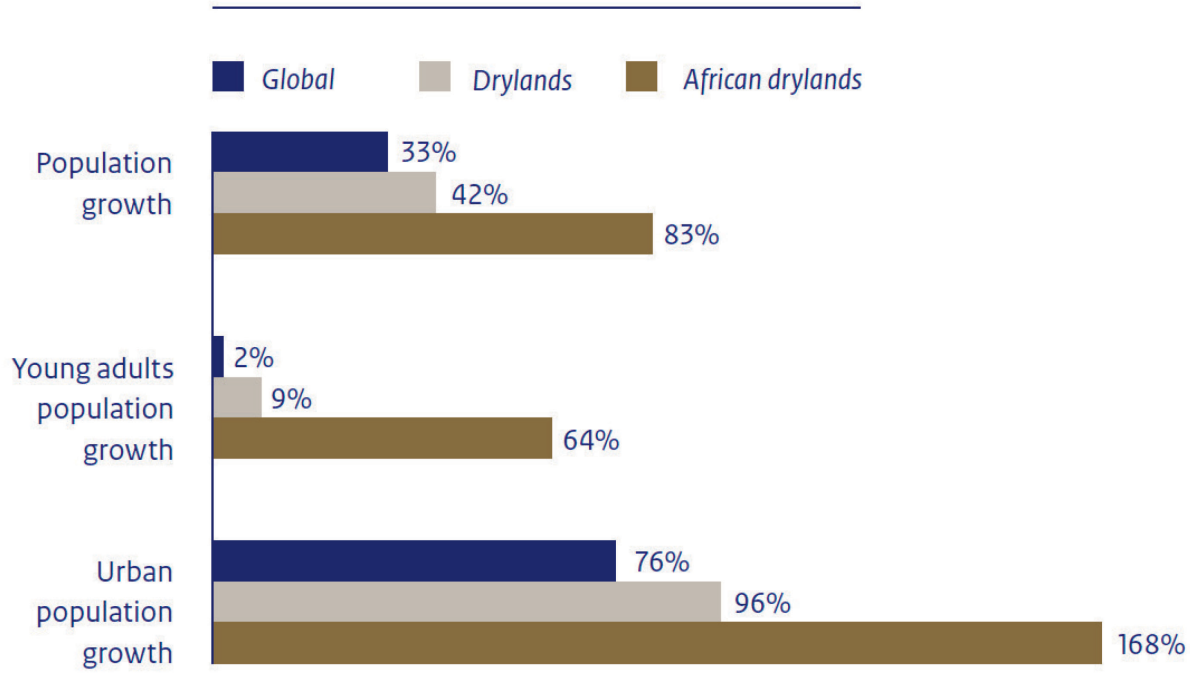


Figure 3.2 Population growth, growth in the number of young adults and urban growth in 2050 relative to 2010.

Migration and sea level rise

There is one impact of environmental change that will definitely influence migration of people living in coastal, low laying areas: sea level rise. However, the exact numbers of migrants will depend on demographic developments and the capabilities to adapt, largely depending on socio-economic developments and governance strategies.

Increasing inundation and coastal erosion impacts of rising seas in combination with more intense storms are felt incrementally, over time, with assets and security slowly being eroded, and with sudden shocks being part of the process. The decision to move and the moment to move depend for largely on individual characteristics, such as education, gender or financial means (Richards and Bradshaw, 2017).

Most of the world megacities are located in coastal zones, and many are situated in large deltas where specific economic, geographic and historical conditions attract people (Neumann, Vafeidis et al., 2015). The projected urbanisation of urban deltas may increase the vulnerability of populations to sea level rise in the future (Government Office for Science, 2011).

Sea level rise will not be uniform across regions. According to the IPCC, by the end of the 21^{e} century it is very likely that 95% of the coasts will experience sea level rise and about 70% of the coastlines worldwide are projected to experience sea level rise within 20% of the global mean (IPCC, 2014) (Figure 3.3).

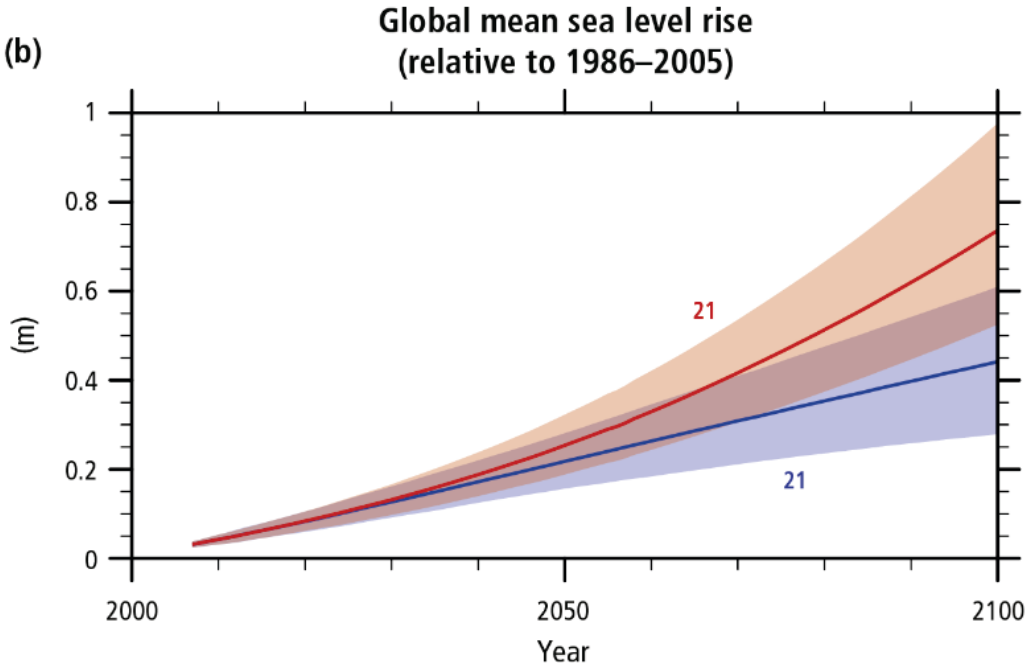


Figure 3.3 Sea level rise projections under two scenarios as determined by multi-model simulations. All changes are relative to the 1986–2005 period (IPCC, 2014).

Migration/relocation as coping mechanism

Although academic discussion exist about the actual weight environmental variables have on migration, the UN Refugee Agency sees the links between climate change and natural disasters on the one hand, and environmental degradation and displacement on the other, as undisputed (Goodwin-Gill and McAdam, 2017; Rigaud, 2018). Fact is that temporary migration, especially during the dry season, has always been a coping mechanism of human communities that directly depend on seasonal variability, especially in large parts of Africa and the Middle East (Barrett and Santos 2014, Brown 2015). Increasing water stress together with population growth in vulnerable areas can increase the number of seasonal migrants, or lead to permanent instead of temporary migration. Chronic environmental degradation, such as long-lasting and reoccurring drought and increasing soil degradation, generally first leads to intensified labour migration, as people seek to supplement local incomes through remittances (Raleigh et al., 2008). Migration or temporary migration due to extreme flooding also has always been a coping mechanism, possibly intensifying any existing tension in the receiving areas (Black, Bennett et al., 2011; Ghimire, Ferreira et al., 2015)

The UNHCR sees planned relocation as an adaptation strategy for those who are not able to move away from areas that are highly disaster prone or too dangerous for human habitation (UNHRC, 2015).

Conclusions

Migration processes are complex and driven by a range of social, economic, political and environmental factors. However, certain factors can be regarded more important than others. Since water-stress-related migration primarily occurs in regions where people's livelihood is directly dependent on their environment, regions with a relatively low GDP are more at risk. Demographic characteristics are of importance, since a relatively young population is more mobile than an older population.

Sea level rise without doubt will leads to migration and displacement. The number of people affected will vary per region, depending on the actual local sea level rise, adaptation measures and demographic characteristics.

3.3 Conflict

All potential links between water insecurities and conflict are more or less contested in academic literature. There is substantial evidence, however, that water security threats affect economic growth, especially in low-income countries, and poverty especially in combination with the absence of effective governance are major factors that increase conflict risk (Collier, 2007; Hallegatte, Bangalore et al., 2016). Water-related events can undermine institutions that provide public goods and thereby weaken states. Especially water stress situations can be linked to conflict situations, exaggerating existing risk. The construction of hydropower dams is another factor that may increase the risk of conflict, from forced displacement on a local level, to increased tension about water sharing in international river basins.

Definition of conflict

The concept of conflict is not clearly or uniformly defined in conflict research. Research articles and research institutes define conflict in different ways, using different variables. In our study, conflict was not limited to armed, violent conflict. Figure 3.4 gives a conceptual overview of the different levels of conflict. Unrest due to shocks, resulting in social disruption and tension over remaining resources together with increasing temporary or structural migration, can also result in situation of non-violent conflict. Social disruption is generally defined as the alteration or even breakdown of social life, as a result of economic shocks and decline, decreased sense of safety, unequal distribution of aid or remaining resources and health issues such as epidemics. Communities prone to social disruption often have low social and environmental resilience (Adger, 2000; Kawachi and Berkman, 2000).

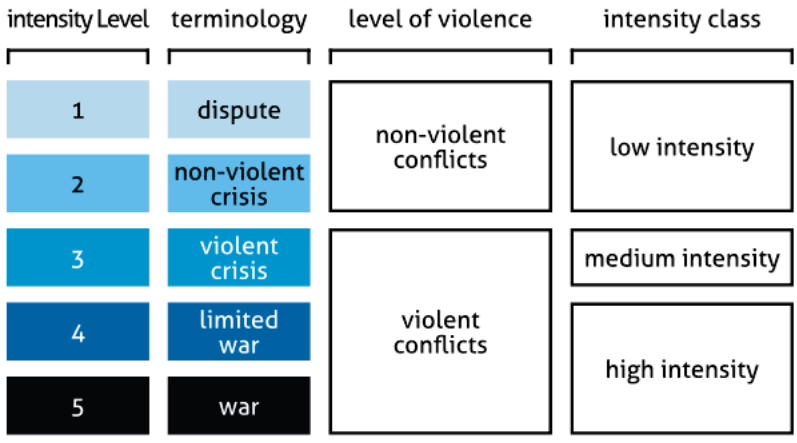


Figure 3.4 Different levels of conflict intensity. Adapted from HIIK (2016).

The Global Peace Index

The Global Peace Index (GPI) scales countries on their level of peacefulness, apart from a specific definition of conflict. For this reason the GPI has been used in the statistical analyses (Visser and De Bruin, 2018) that sustain the hotspot maps. The GPI is based on 23 indicators in three overarching categories: ongoing domestic and international violence, public safety, and security and

militarisation. The indicators have been selected and weighted by experts from all around the world and are sourced from the latest available data from a wide range of international institutes: including the Uppsala Conflict Data Program (UCDP and the Stockholm International Peace Research Institute (SIPRI) (Institute for Economics and Peace, 2016).

Pathways that link water to conflict

In the PBL background report *Linking water security threats to conflict* (2018) ten pathways have been distinguished based on historical and ongoing case studies. Since discussions about specific pathways differ, part of the IPCC framework on uncertainty (Mastrandrea, Mach et al., 2011) has been qualitatively applied by assessing the confidence level based on the level of evidence and agreement for each individual pathway.

This literature study shows that conflict is the result of complex and context-specific processes, involving many more or less influential factors. Water insecurities are never the only cause of conflict. Risks derive from the social and economic impacts of water stress, economic shocks due to precipitation variability and natural disasters and the distribution of power over water, in existing conflict and in situations of distrust between nations. No link between water quality issues and violent conflict have been found, despite the fact that water quality issues lead to more casualties than conflict.

These so-called pathways are summarised in Table 3.2. Further intensified water challenges, mainly due to a lack of water, may impact political stability on local and international scales, in the years ahead, in regions already vulnerable to water insecurities. In most parts of the world, though, climate and water conditions do not directly threaten peace. Regions already prone to conflict, due to instability of government institutions, conflict traps, poverty and inequality, demographics and low levels of education face higher risks of conflict-related water security threats.

Table 3.2 Ten pathways linking water to conflict. The case studies sustaining the pathways can be found in the report by de Bruin et al. (2018).

Pathway	Confidence	Context	Scale
Local water stress (droughts, economic scarcity, inaccessibility) may induce conflict over remaining water and food, in fragile contexts	Robust evidence Medium agreement	Economically and politically deprived population High dependence on rainfall Environmental mismanagement Existing tension/grievances between communities	Local
Variability in precipitation 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	Moderate evidence, medium agreement	Direct dependence on rainfall for agriculture and plagued by cattle raidingl Existing historical tension over land and water rights	Local–regional
A shortage of arable land Resulting from land degradation and water stress (drought, economic scarcity and inaccessibility) may induce local conflict over the (remaining fertile land, not necessarily IN the same location or at the same moment	Moderate evidence medium agreement	Deprived population High dependence on rainfall No land policy, or land policy that is percieved as unfair; abuse of power by elite factions Existing tension between communities or with international investors Incoming migration and population pressure	Local–regional

Food price spikes as a result of water-related disaster may accelerate or stimulate local/regional rioting increasing conflict risks	Moderate evidence High 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 relationships
Migration and displacement may increase as a result of water-related disaster, possibly causing tension in the receiving areas	Little evidence Low agreement	Demographic composition of region of origin and receiving areas Economically and politically deprived population, food insecurity Existing conflict in the receiving areas and/or region of origin Networks Political freedom	Local–international
Economic shock as a result of natural disaster can increase inequality, adding to social disruption and grievances, and increase conflict risk	Little evidence Low agreement	Low adaptive capacity, existing grievances, unfair distribution of aid (increasing grievances), poverty trap	Local–regional
The construction of mega dams may lead to tension between countries within a situation of power struggle and shortages due te overexploitation	Moderate evidence High agreement	Existing grievances and distrust between countries Rapidly developing projects Rapid political changes Little institutional capacity	Transboundary
Water can be used as a weapon or strategic tool/measure in existing conflicts, possibly exacerbated by water stress	Robust evidence High agreement	Existing conflict, under conditions of food/water scarcity Highly vulnerable vital infrastructure	Local – regional
Control over water resources or water reservoirs can be pursued by nations or terrorist/rebel groups, Under conditions of water stress	Limited evidence Low agreement	Existing tension between nations, suppression, (perceived) water stress, history of conflict	International
A melting Arctic may change existing regional geopolitical relationships and cause interstate tension/conflict	Moderate evidence Medium agreement	Existing grievances and distrust between countries Conflicting national interests Little communication or openness	International

Water-stress-related conflict

Water-stress-related conflict is often attributed to mismanagement rather than drought (Raleigh and Urdal, 2007; Allouche, 2011). Resource scarcity in general 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 (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 four.

Even though it seems unlikely that local water stress will be a single and direct cause for local conflict, in combination with other variables, especially poverty, insufficient diversified economies, and lacking governance structures, water stress can consolidate conflict (Moench, 2002; Robins and Fergusson, 2014; Von Uexkull, 2014). Water stress may, under certain circumstances, also have a countervailing effect on conflict because of its negative impacts on fighting capabilities (Salehyan and Hendrix, 2014).

Increased conflict risk as a result of water stress in already fragile and conflict prone areas is described by a wide range of case studies (Benjaminsen, 2008; Robins and Fergusson, 2014; Von

Uexkull, 2014; CORDAID, 2015), not only in academic literature but also as reported by NGOs. The level of evidence, therefore, is robust. Although there is ample evidence, a number of scholars showed that there are contradictory conclusions and far more important drivers of conflict, such as financial crises (Turner, 2004; Theisen, Gleditsch et al., 2013).

Transboundary tension related to dam construction

In recent decades, numerous mega-hydropower dams have been constructed, under which the three Gorges Dam (China), Itaipu Dam (Brazil, Paraguay) and the Guri Dam (Venezuela),[2] in order to meet increasing demands for energy. Where some see hydropower dams or dams for irrigation purposes as the solutions for sustainable development, others consider the construction of these dams as non-transparent processes where human rights and the quality of ecosystems are considered less important than economic benefits (Zarfl et al., 2015). Historically, dams have had severe impacts on local communities. An estimated 80 million people have been displaced by dam projects worldwide (Walicki, Ioannides et al., 2017). The faith of these people is large unknown, but evidence shows that those affected often do not receive compensation, and the majority of these people remained or became poor (Moore, Dore et al., 2010). Social justice and conflict issues have occurred among others in Colombia (Martínez and Castillo, 2016), Chile (Carruthers and Rodriguez 2009), Myanmar (Kirchherr, J. Charles et al., 2016) and Brazil (de Azevedo, Miranda et al., 2016).

Aaron Wolf, an often cited scholar specialised in transboundary water conflict, considers an increased likelihood of conflict within basins the result of insufficient institutional capacity and rapid physical changes within a basin, especially the construction of large scale dams (Wolf, 2001; De Stefano, Petersen-Perlman et al., 2017). Numerous regions still have large hydropower potentials, especially in Latin America, the Balkans, Asia and Africa (Gernaat, Bogaart et al., 2017). These changes may alter existing or even create new local up to transboundary conflict, strongly depending on the way these dams will be constructed (De Stefano, Duncan et al., 2012; De Stefano, Petersen-Perlman et al., 2017)

The Renaissance Dam in Ethiopia, under construction since 2011, is a contemporary example of a mega-hydraulic dam considered a mayor security threat for both transnational conflicts and social injustice. International relationships within the Nile Basin become increasingly complex due to shifting powers, since the construction of the Renaissance dam challenges the historical hegemonic position of Egypt in the basin (Hammond, 2013). Food security is likely to be undermined, tribes living along the river are threatened by losing their livelihoods, and migration may be triggered, all possibly impacting existing tension, at the local scale (Abbink, 2012).

Cooperation over water

This study primarily focuses on the conflict factor of water. Nevertheless, 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 (Whittington, Wu et al., 2005; Wolf, 2007; Zeitoun and Mirumachi, 2008; Brochmann and Gleditsch, 2012; Link, Scheffran et al., 2016). In international river basins, numerous treaties have created trust and alliances between countries, sometimes in post-conflict situations, and sharing of water resources on community level have also influenced other

[2] Together, these three dams produce almost 250 TW-hour per year (1000 times annual electricity use by Dutch households).

forms of cooperation. This notion is of importance for future water management strategies, but is not being discussed extensively in this study.

However, to better understand the pacifying effect of water, a follow-up policy study towards the pacifying effects of specifically water and environmental security in general would be a valuable addition.

Conclusions

Conflict is an extreme outcome of a combination of risk factors. Discussion exist regarding the major causes of conflict. However, there are two key factors that are assessed in most conflict studies: governance and poverty (Fearon and Laitin, 2003; Collier, 2007; Goldstone, Bates et al., 2010; Besley and Persson, 2011; Hegre, Karlsen et al., 2011; Acemoglu and Robinson, 2012). In the case of water-stress-related conflict, these factors are also central, since these factors shape water management, central for water-related conflict.

Transboundary waters more often cause cooperation than conflict. Basically, the many existing treaties and river basin organisations increase the capacity of riparian countries to avoid severe conflicts. Still, the construction of numerous potential hydropower dams, could lead to increased tension between states, especially in regions where trust between countries is low.

4 Hotspot maps: approaches and result

A number of attempts to model the possible relationship between environmental factors and the probability of conflicts are known from the literature (Hsiang, Meng et al., 2011; Hsiang, Miguel et al., 2013; Hsiang and Burke, 2014; Von Uexkull, 2014). Yet, none of these models are very convincing for the purpose of this project: identifying hotspots. For the relationship between environmental factors and changing migration patterns, models were even less available. The most common ways to model these relationships are based on regression techniques which assume a continuous relationship between driving factors, the input, and changing probability of conflicts or migration, the output. Either in its most simple form of linear regression (e.g. Hsiang and Burke) or in the more complex form of multiple regression, taking into account a number of contextual factors, (e.g. Von Uexkull, 2014), there are a number of objectives. First, conflicts are the outcome of highly non-linear processes. Second, conflicts are exceptions rather than almost natural outcomes of an unfavourable combination of factors (Buhaug, 2014). Third, if found that relationships are statistically significant at all, they were in general very weak, which makes the applicability of these non-mechanistic models under changing future conditions even less credible. Finally, definitions of variables differ per study influencing the outcome of a certain study. However, in our view there is enough agreement on the importance of some of the key contextual factors to at least make some indication of future hotspots of conflict and migration.

The hotspot maps are based on relationships most often mentioned as key in literature (Table 4.1). The thresholds determined for these factors are partly defined by statistical analyses. These relationships have been substantiated in Chapter 3. Water, political and social indicators have been combined to indicate regions where water-stress-related migration, the probability of water-stress-related conflict or pressure on existing collaboration between riparian countries can increase.

The analyses have been done by multiplying the different key indicators, all valued 0, 1 or 2, depending on the level of influence. Areas where the situation at one of the boundaries is considered safe or as having practically no local influence (valued 0) are always considered as having a practically negligible probability of either an increase in migration volumes (related to SLR or water stress) or in conflict risk, from the perspective of these boundary conditions. In other words: in these areas there is hardly any reason to assume that water will be the cause of significant changes in migration volumes or will be related to increasing tension or even conflict the upcoming decades.

To avoid false negatives as much as possible, particularly the lowest threshold values for the middle class (valued 1) are set rather wide. Yet, since the objective was to indicate hotspots, only the areas with the highest scores were eventually mapped (see distribution tables in Sections 4.1 and 4.2). Areas identified as hotspots should primarily be valued in relative terms: if water plays a significant role, then these are areas where the probability of changes in migration volumes is greater or the increase in tension is more likely, in comparison with other areas.

Table 4.1 Hotspot maps

Map title	Water-related indicator	Political/social indicator
Dryland hotspots of potential migration associated with water stress	Water stress (Dynamic Water Stress Index (DWSI)	Population growth Growth in youth bulge Income (GDP USD/CAP)
Hotspots of potential migration, due to 1 metre sea level rise	Sea Level Rise	Number of people living in flood-prone areas (absolute or relative) Coping capacity (GDP USD/CAP)
Hotspots of potential conflict risk associated with water stress in 2050	Water stress (DWSI)	Governance Income (GDP USD/CAP)
Pressures in river basins, related to dam construction		Number of people who could be displaced by the construction of dams Governance International water treaties

4.1 Migration maps

Potential hotspots of migration associated with water stress in 2050

Water-stressed-related migration is migration affected by water stress, displacing people whose income directly depends on the availability of water (e.g. farmers and pastoralists). To make this indication, four indicators are used: DWSI, youth bulge, population growth and GDP in USD.

Each water province [3] (Straatsma, Droogers et al., 2014) gets a value of 0, 1 or 2 for GDP, Population growth, DWSI and the size of its youth fraction (youth bulge). Values are multiplied to derive at the final composite indicator, since all factors are of importance for water-stress-related migration (Tables 4.2 and 4.3).

Table 4.2 Threshold value per indicator

	Threshold values	
Score	2	1
GDP x 1000	10	20
Pop	1.9	1.29
DWSI	5	3
Youth Bulge	0.26	0.20

[3] Water provinces are a composite of river basins and administrative regions. This geographical scale has been used throughout this project (Straatsma et al. 2014).

Table 4.3 Number of water provinces per score and belonging colours

Score	number	legend
16	37	
8	84	
4	36	
2	43	
1	57	
0	1036	
no data	311	

Water stress – DWSI

The water stress index is based on the DWSI (Dynamic Water Stress Index) by Wada et al. (2011). Further details on classification can be found in the document on water stress. The following values are given per category, based on severity (scores from high (5) to low (1)):

WADA	Value
1	0
2	0
3	1
4	1
5	2

Population growth

Population growth projections for 2050 are derived from the SSP2 'medium scenario' by the International Institute for Applied Systems Analysis (2016).

Threshold values are based on average global growth rates. Since the average population growth rate is 129% from (7.6 billion now, 9.8 billion in 2050 = 29% increase), this number is used as the first threshold. Countries facing a population growth larger than 1.9 (almost doubling) is defined as the second thresholds and are given 2 points.

Youth Bulge

Young people are more likely to move than older people (Black, Adger et al., 2011; Global Migration Group, 2014). The 15–30 year fraction was used to classify this indicator. Population projections are derived from the SSP2 'medium scenario' by the International Institute for Applied Systems Analysis (2016) (Figure 4.1). The threshold values are set at 0.20 and 0.26 so both classes would cover around 20% and 50% of all countries (93 out of the 193 countries have a fraction larger than 0.20 and 32 thereof are projected to have a fraction larger than 0.26).

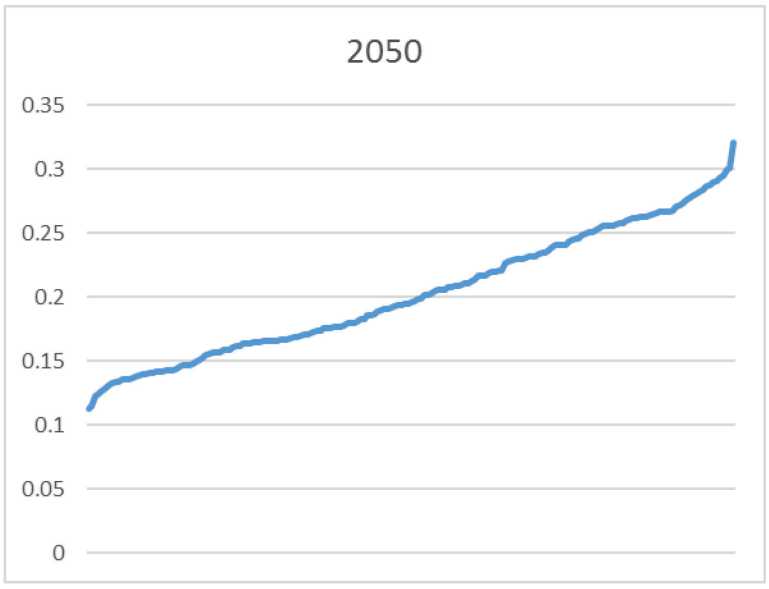


Figure 4.1 Distribution of the fraction aged 15–30 of the projected (SSP2) total population of all (193) countries in 2050.

GDP

Gross domestic product (GDP) projections for 2050 are derived from the SPSS2 'medium scenario' by the International Institute for Applied Systems Analysis (2016).

The GDP threshold values for this map are based on the relationships between GDP and the average GDP value added by agriculture. Countries with a GDP of more than USD 20,000, in general, have a low dependence on agriculture. Figure 4.2 shows that most countries with a GDP below USD 10,000 are for more than 10% dependent on agriculture. Therefore, the thresholds of USD 10,000 and USD 20,000 are used.

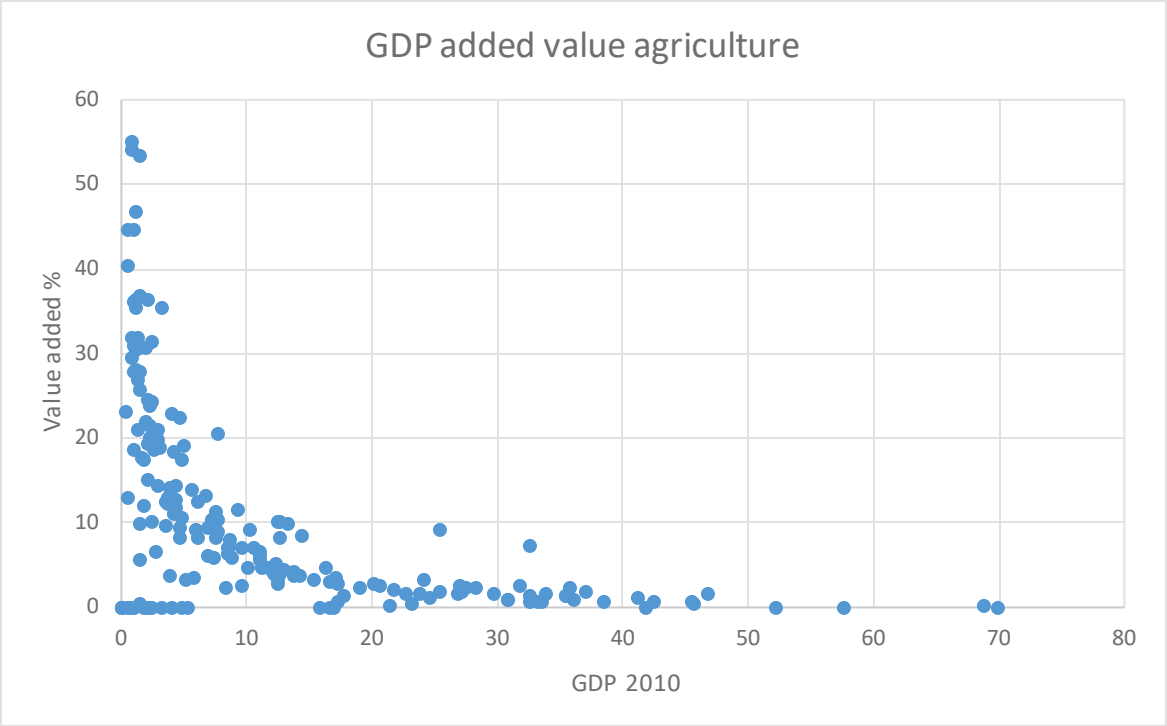


Figure 4.2 Agricultural value added by agriculture (World Bank 2010).

Potential hotspots of migration due to sea level rise in 2050

The potential number of people affected by a rise of 1 meter. This number is taken as absolute and relative to the country's number of inhabitants. This combined with the coping capacity of counties, expressed in GDP (Table 4.4).

Table 4.4 Threshold value per indicator

Elements	2	1
People living below 1m SLR Absolute number	5000000	500000
People living below 1m SLR Relative number	10%	1%
People living below 1m SLR Total	MIN(2,sum abs+rel)	
Coping capacity	10	25

Sea Level Rise

1 meter global sea level rise on all shores.

Population

Population growth projections for 2050 are derived from the SSP2 'medium scenario' by the International Institute for Applied Systems Analysis (2016).

GDP

Gross domestic product (GDP) projections for 2050 are derived from the SPSS2 'medium scenario' by the International Institute for Applied Systems Analysis.

The capacity of countries to adapt to the rising sea level is key to the assessment of the probability of migration. If nations are able to make substantial investments in flood risk management (FRM), the need to move will decrease or even dissapeare. Base for the assessment of the threshold values is

the assumption that most OECD countries (small Pasific islands excluded) would be able to invest, at least to a certain level, in FRM. OECD coutries with the lowest GDP per capita were all located in the Balkan region (o.a. Bosnia Herzegovina, Albania and Montenegro). Based on their GDP per capita, we rounded the upper threshold value up towards USD 10,000. In order to avoid false negatives, we set the lower threshold value to USD 25,000 (covering around half of all OECD countries in 2010).

4.2 Conflict maps

Hotspots of potential local conflict associated with water stress in 2050

The map of local conflict associated with water stress is created by combining three indicators: for governance, water stress and GDP. Since all three are conditional factors for water-stress-related conflict, the three indicators are multiplied, so all water provinces that have one or more indicators valued at zero are outside the risk zones.

Each water province received a value of 0, 1 or 2 for GDP, DWSI and governance. Values are multiplied to derive at the final composite indicator, since all factors are import for water-stress-related migration (Tables 4.5 and 4.6).

Water stress conflicts: ECC Factbook https://factbook.ecc-platform.org/ (Lukas Rüttinger, Dan Smith et al., 2015)

See Appendix 1. to see the complete list of reported water-stress-related conflicts included.

Disclaimer: Most dots on the map represent numerous conflicts in the same region, especially in Sub-Saharan Africa. Some conflicts included already go on for decades, with a changing intesity, depending on, for example, droughts. Not all conflicts related to water are included in the list, however, major and lingering conflicts are.

Table 4.5 Threshold value per indicator

	Threshold values	
Score	2	1
Water stress (DWSI)	5	3
Governance	2.20	5.25
GDP x 1000	10	20

Table 4.6 Number of water provinces per score and belonging colours

Score	Number	legend
8	27	
4	91	
2	103	
1	76	
0	996	
no data	311	

Governance

Governance 2016 is a composite from:

- Governance effectiveness from the Worldwide Governance Indicators (Kaufman and Kraay, 2015)
    - (http://info.worldbank.org/governance/wgi/index.aspx#home)
- Corruption Perception Index 2016 (Transparency International, 2017)
    - https://www.transparency.org/news/feature/corruption_perceptions_index_2016

The thresholds for the governance indicator are determined according to calculations by Visser et al. (2018), shown in Figure 4.4. The dependent variable, the Global Peace Index (GPI) (2016), determines the peacefulness of a country. The most important explaining variable—out of a wide range of variables, including GDP, inequality, employment—is that of governance with the value of 5.25 and the second most important is governance with a value of 2.2 (Figure 4.3).

The New Climate for Peace ECC Platform (Lukas Rüttinger, Dan Smith et al., 2015) 54 water-stress-related conflicts have been used to validate the finded thresholds. With the exception of Israel, all these countries have a Governance index <= 5.25 (Figure 4.4), which means that the choosen thresholds include major historical conflicts in which water stress may have played a role.

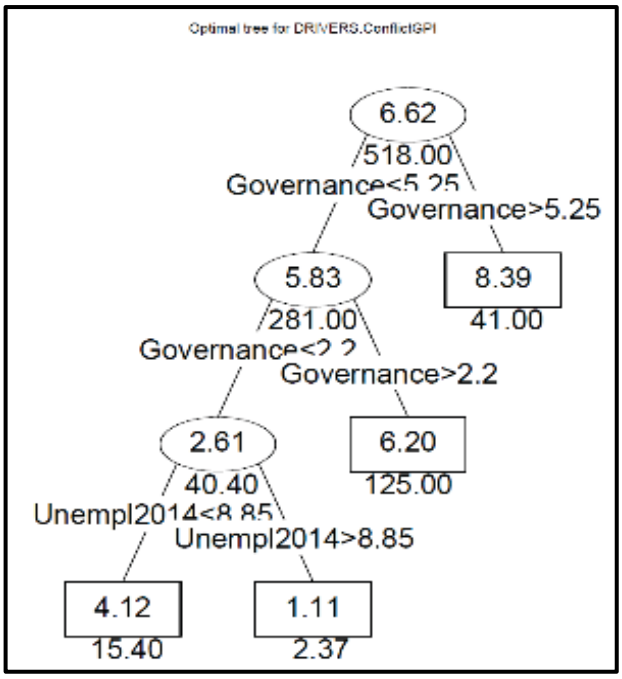


Figure 4.3 Regression tree with the Global Peace Index (GPI) Index as the dependent variable. The GPI lies in the range of 0.0–10.0, with high values pointing to countries with better peace conditions. The independent variable Governance also lies in the range of 0.0–10.0, with higher numbers pointing to better governance. Unemployment stands for the percentage of unemployed people. Explained variance: 64%. Analysis is for 139 countries for which data is available on all indicators considered. (Visser and De Bruin, 2018)

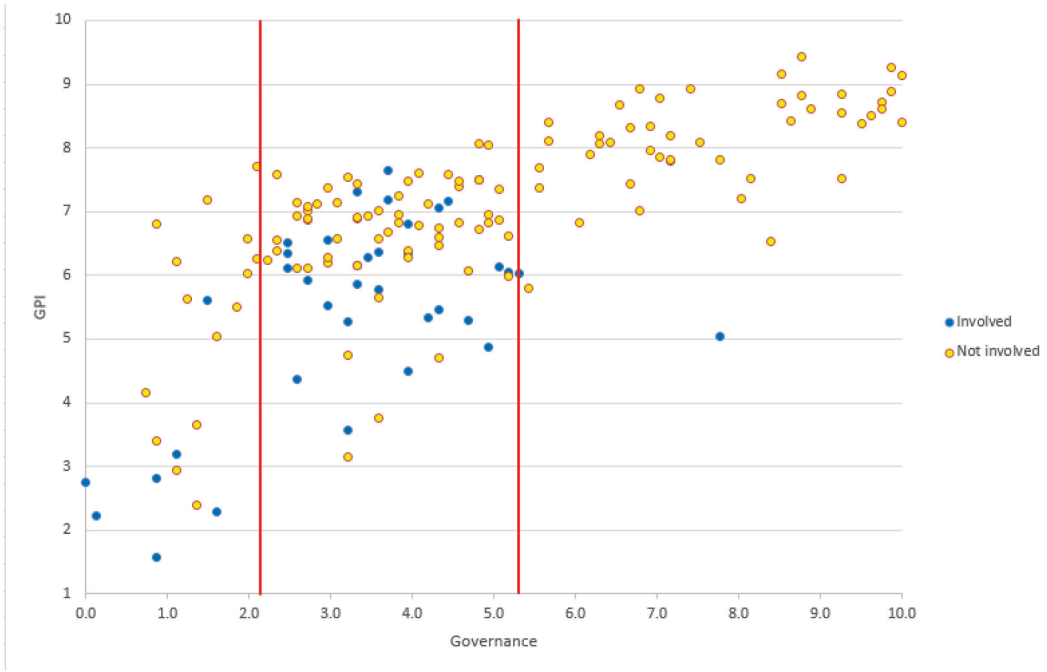


Figure 4.4 Relation between the Governance indicator and the Global Peace Index (GPI). Blue dots represent countries with a history of conflict in which water stress played a role (1944–2017). The red lines are threshold values used in the model.

GDP

Gross domestic product (GDP) projections for 2050 are derived from the SPSS2 'medium scenario' by the International Institute for Applied Systems Analysis (2016).

Threshold values are set in such a way that, in 2010, all nations with a history of conflict that could be linked to water (list see Appendix 1), at least have an index value of =1 (with the exception of Isreal, which is considered a special case). The upper boundary is set to 20,000 USD/cap, being the first split value when a regression tree analysis is performed on all relevant variables (with the exception of

Governance) (Visser et al. 2018). Also, most countries with a GDP per capita of over USD 20,000 have a GPI of more than 6, which means they can be considered as relatively peaceful (Figure 4.5). Since most of the countries with a history of conflicts related to water have a GDP per capita that is lower than USD 10,000, these countries are classified with 2 points. Countries where GDP per capita is between USD 10,000 and 20,000 are classified with a 1.

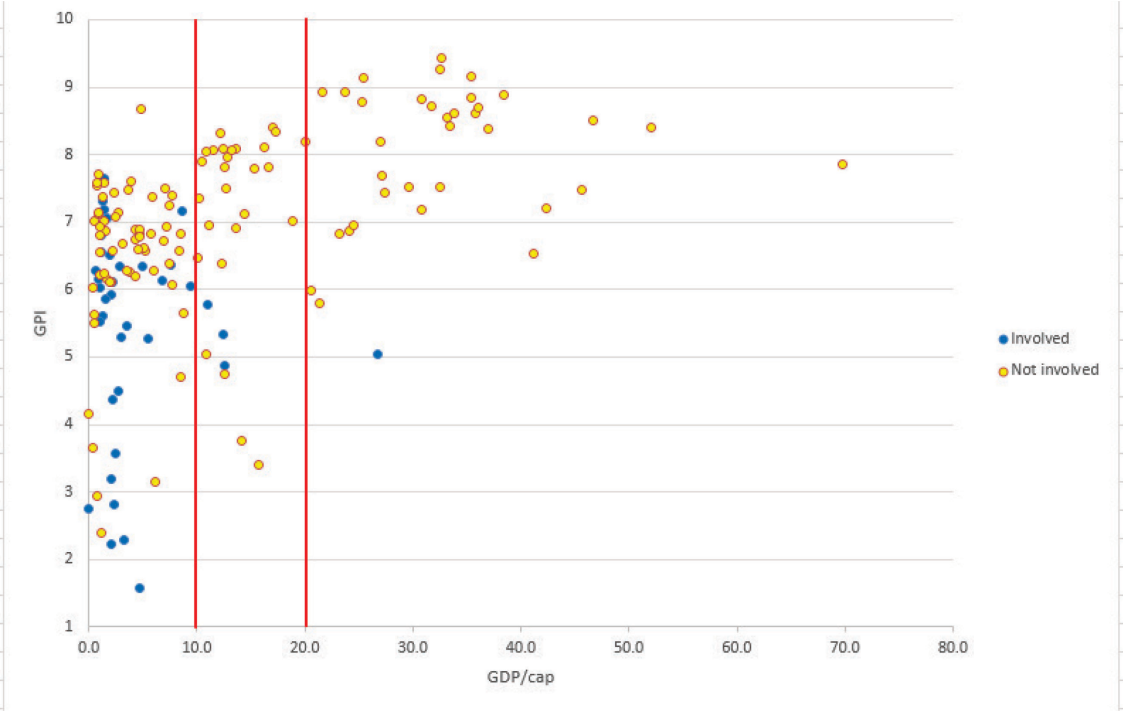


Figure 4.5 Dots represent countries, plotted for their GPI value and GDP/cap value. Blue dots are countries where water-related conflict has emerged since 1944. Yellow dots are countries not involved in water-related conflict.

Water stress: DWSI

The water stress index is based on the DWSI (Dynamic Water Stress Index) by Wada et al. (2011). Further details on classification can be found in the document on water stress. The following scores are given per category based on severity (5 is high, 1 is low):

WADA	Value
1	0
2	0
3	1
4	1
5	2

Pressure in river basins related to dam construction

The map includes two potential sources of conflicts due to the construction of hydropower dams. The first one is on the transboundary level between riparian countries, the second one is on the local level due to the forced displacement of people. Data on potential hydropolitical tension at the international level are taken from UNEP-DHI and UNEP (UNEP-DHI and UNEP, 2016; UNEP-DHI and UNEP, 2016), which is based on the work of De Stefano et al. (2017). De Stefano et al. base their analysis on the level of hazard due to new water resource infrastructures in combination with the

level of institutional vulnerability, expressed by the absence of relevant treaty provisions and river basin organisations. On the local level, the potential number of forced displacements is indicated.

Dam-related conflicts: ECC Factbook – A new climate for peace. Selection: dam-related conflicts. *https://factbook.ecc-platform.org/* (Adelphi, 2017)

Environmental Justice Atlas – expert judgement major dam-related conflicts https://ejatlas.org/ (Temper et al. 2015)

See Appendix 3, for the conflict specifications. Disclaimer: Not all conflicts that are related to dam construction have been included, however, based on expert judgement, the major dam-related conflicts are.

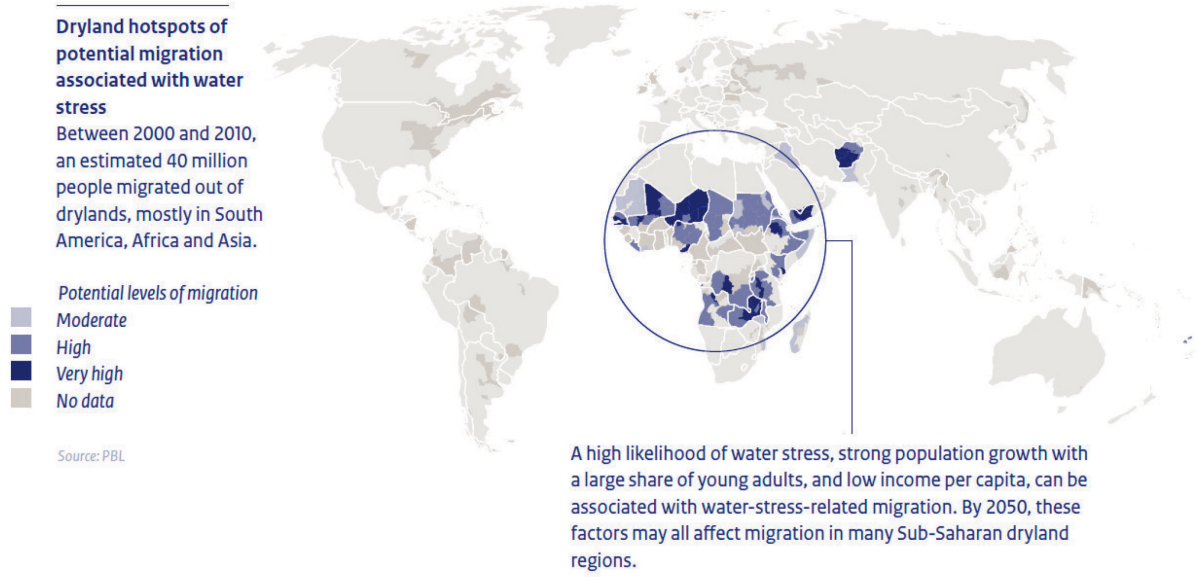
Hydropolitical tension: downloaded from http://twap-rivers.org/indicators/# *(received 2 February 2018)*

Number of people potentially displaced: Our assessment builds on the work of Gernaat et al. (2017), who compiled a map of all locations where potentially hydropower dams could be constructed. From this list a selection was made of those dams, where the production of electricity could be economically feasible (see the document on energy). People living in the affected areas of potential dam construction (to crease reservoirs) were included as the number of potential displaced people.

4.3 Map overlays – hotspots

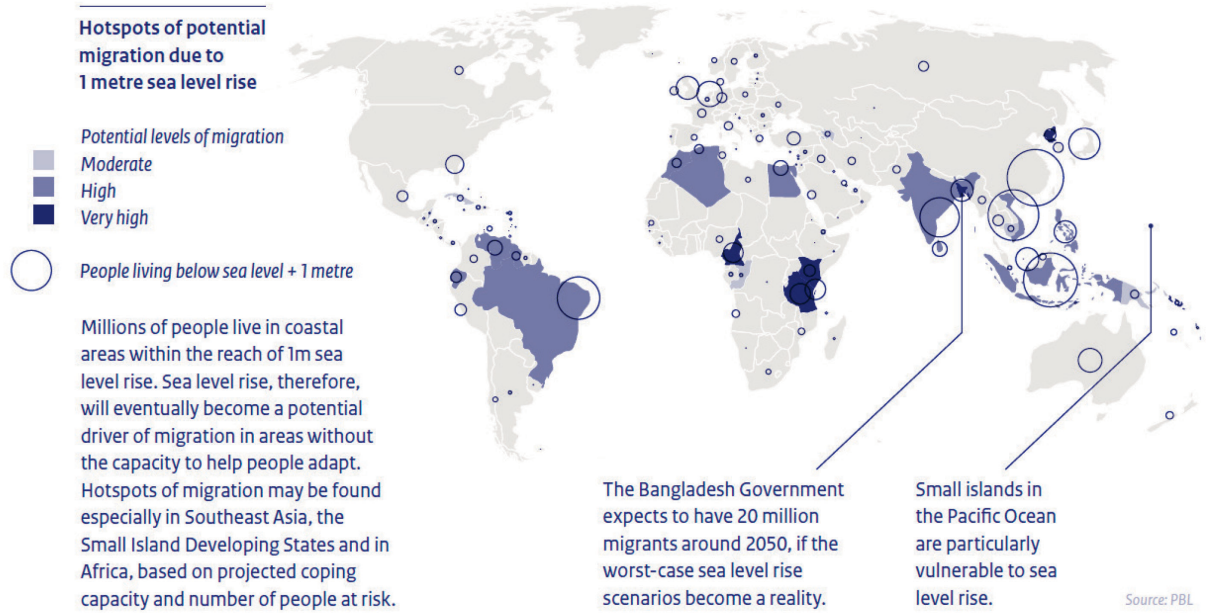
In this section, the hotspot results will be shown as presented in the book *The geography of future water challenges*, including a small accompanying text (Map 1-4).

Dryland hotspots of potential migration associated with water stress



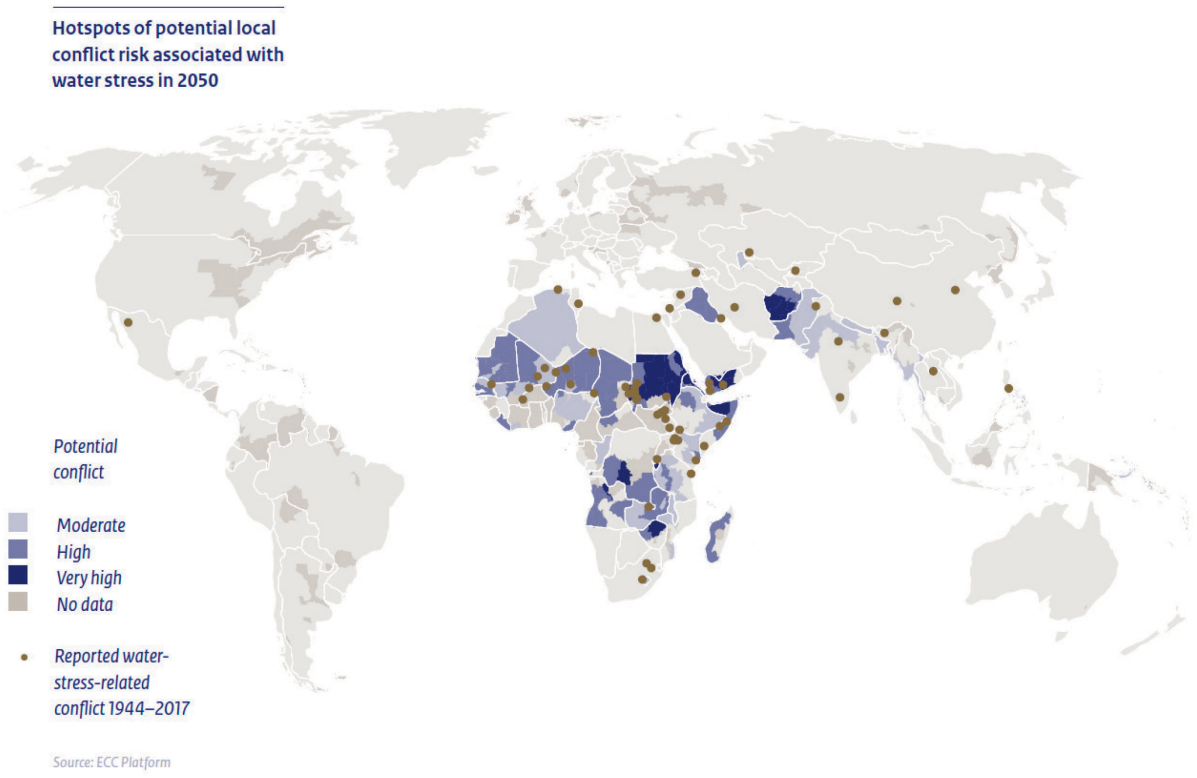
Map 1 The impacts of water stress are seen to be a driver of migration. Especially in areas where many people are employed in agriculture this is the case, since water availability has a strong impact on agricultural productivity. The propensity to migrate is also generally higher amongst younger people. Therefor, the demographic characteristics of a region influence who moves in response to economic changes that are influenced by water stress. Under a business-as-usual scenario, especially regions in Sub-Saharan Africa can face migration related to water stress.

Hotspots of potential migration due to 1 metre sea level rise



Map 2 When the sea level rises, an increasing number of people living in low laying coastal zones will be at risk. The capacity of a country to protect people at risk is largely dependent on money available for adaptation, and thus on GDP. Especially people living in large cities in economically less developed countries in coastal zones will be at risk. Under a business-as-usual scenario, over 150 million people will be at risk when the sea level rises with 1 meter.

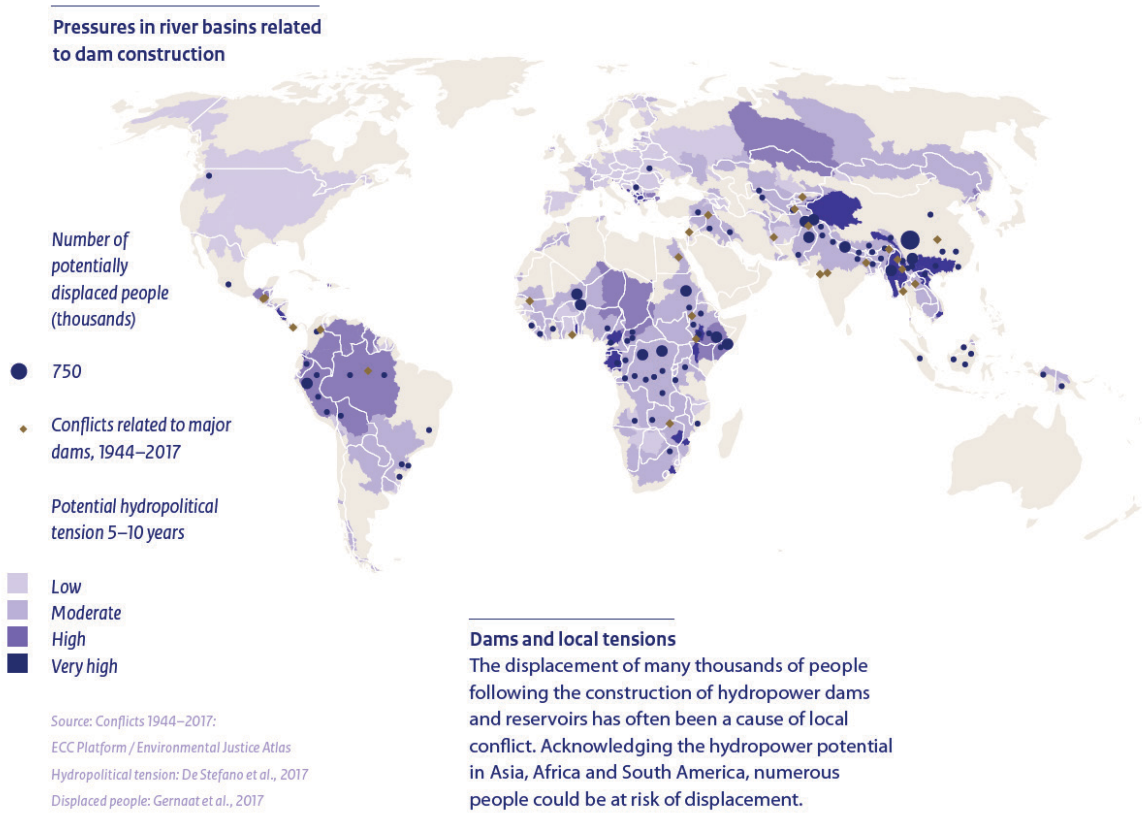
Hotspots of potential local conflict risk associated with water stress in 2050



Map 3 Water stress can be associated with local conflict, especially in those regions where governance is poor and GDP is low, since these characteristics decrease the ability of people to deal with water stress. However, relationships are context

specific and conflict is largely influenced by historical conflicts and water management. The map shows reported water-related conflicts. However, each year, there are numerous local and small-scale conflicts between farmers, for example in Pakistan and India, about irrigation water, especially in dry years.

Pressures in river basins related to dam construction



Map 4 The construction of large-scale dams can have huge consequences, both on local as on international scale. Locally, people can be displaced due to dam construction, especially people living in certain regions of Africa and Asia face displacement. Hydropolitical tension between riparian countries can rise due to dam construction, however, institutional capacity, the presence of river basins treaties and variability in water availability also affect tension in river basins.

5 Discussion, conclusion, recommendations for further research

5.1 Discussion

It is important to note that most of the research used for this study is based on historical data and case studies and it remains questionable to what extend historical precedents are applicable to the future. While important studies have been done on issues touching on climate change, migration and conflict, the scale of these long-term challenges seems to be far greater than our collective ability 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 climatological changes on conflict and migration.

Securitisation of climate and water?

Putting climate change, in this case channelled via water-related events, as a security threat has been criticised 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 relationships are still contested (Brzoska, 2009; Hartmann, 2010; Boas, 2015). A recent study criticises the climate—conflict research discourse, claiming that too many case studies focus on conflict areas, and by doing so, include only a few global regions (Adams, 2018). Contemporary studies would be barely informed by climate change vulnerability. This report not only takes into account the water-related stresses that are caused by climate change (weather variations), but also includes socio-economic pressures and dam construction, since these pressures are at least as important, given the large number of dams presently under constructions or planned for the coming years.

5.2 Conclusion

Water security plays a role in social, political and economic processes, just as these processes can influence water security. However, water is not perceived as a sole and direct cause of conflict and migration; it interrelates with other factors. Thereby can water be used as a political tool or weapon, both in local conflicts or during tension in transboundary river basins, where the construction of dams can affect relationships between riparian states.

It is relevant to look into the relationship of water and geopolitics. With climate change becoming more profound and demographic growth projected to rise, water challenges could indeed intensify the relationship with political stability in the years ahead. Despite the limitations and constraints, it seems obvious that, if temperature and rain fall patterns in combination with other global socio-economic change, this may have a negative effect on conflict risk or migration, these potentially adverse effects will predominantly become apparent in Sub-Saharan Africa and in Southwest Asia. Increasing migration flows due to sea level rise might become apparent in selected countries in South America, Africa, Southeast Asia and Oceania. South America, Africa and Southeast Asia are regions where the potentially risk of local conflict due to the displacement of people resulting from the construction of hydropower dams might increase. On an international level the construction of dams may raise tension between riparian states particularly in South America, Africa and large parts of Asia.

5.3 Gaps and recommendations for future research

All the analyses outlined in this publication point out that contestation on the exact relationships and mechanisms remains. To identify where the relationship between water and geopolitics or conflict is a reality, and where it is not, we propose to carry out in-depth case studies during the next phase in unstable regions where environmental stresses have been indicated to play a role (e.g. in the hotspots identified). This could lead to new insights on how water biophysical and societal systems intersect. We will use a political economy analysis to map actors, networks etc.

Another topic that should be analysed better is the pacifying effect of water resources on local and international levels. Water is a potential source for collaboration, and therefore could be an element of peacebuilding processes. Especially in developing adaptation programmes, it will be of interest to know how water can inspire conflict management and improve livelihoods.

References

Abbink J. (2012). Dam controversies: contested governance and developmental discourse on the Ethiopian Omo River dam. Social Anthropology 20(2): 125–144.

Acemoglu D and Robinson JA (2012). Why Nations Fail. Profile Books LTD, London.

Adelphi (2017). ECC Platform. Retrieved 10 October 2017, from https://www.ecc-platform.org/.

Adger WN. (2000). Social and ecological resilience: are they related? Progress in Human Geography 24(3): 347–364.

Adger WN, Pulhin JM, Barnett J, Dabelko GD, Hovelsrud GK, Levy M, Spring UO and Vogel CH. (2014). Human Security. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, Cambridge University Press: 755–791.

Al Jazeera (2012). Risk of water wars rises with scarcity. Retrieved 03 May 2017, from http://www.aljazeera.com/indepth/features/2011/06/201162219314723165 3.html.

Allouche J. (2011). The sustainability and resilience of global water and food systems: Political analysis of the interplay between security, resource scarcity, political systems and global trade. Food Policy 36: Supplement 1, 3–8.

Barrett CB and Santos P. (2014). The impact of changing rainfall variability on resource-dependent wealth dynamics. Ecological Economics 105: 48–54.

Benjaminsen TA. (2008). Does Supply-Induced Scarcity Drive Violent Conflicts in the African Sahel? The Case of the Tuareg Rebellion in Northern Mali. Journal of Peace Research 45(6): 819–836.

Besley T and Persson T. (2011). The Logic of Political Violence. The Quarterly Journal of Economics 126(3): 1411–1445.

Black R, Adger WN, Arnell NW, Dercon S, Geddes A and Thomas D. (2011). The effect of environmental change on human migration. Global Environmental Change 21, Supplement 1: S3–S11.

Black R, Bennett SRG, Thomas SM and Beddington JR. (2011). 'Climate change: Migration as adaptation. Nature 478(7370): 447–449.

Black R, Kniveton D, Skeldon R, Coppard D, Murata A and Schmidt-Verkerk K. (2008). Demographics and climate change: future trends and their policy implications for migration. Development Research Centre on Migration, Globalisation and Poverty. University of Sussex, Brighton.

Boas I. (2015). Climate Migration and Security: Securitisation as a Strategy in Climate Change Politics, Routledge.

Brochmann M and Gleditsch NP. (2012). Shared rivers and conflict – A reconsideration. Political Geography 31(8): 519–527.

Brown O. (2015). Migration and Climate Change Migration Research Series Geneva, International Organization for Migration.

Brzoska M. (2009). The securitization of climate change and the power of conceptions of security. S&F Sicherheit und Frieden 27(3): 137–145.

Brzoska M and Fröhlich C. (2016). Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies. Migration and Development 5(2): 190–210.

Buhaug H. (2016). Climate Change and Conflict: Taking Stock. Peace Economics, Peace Science and Public Policy 22(4): 331–338.

Buhaug H, Benaminsen TA, Sjaastad E and Theisen OM. (2015). Climate variability, food production shocks, and violent conflict in Sub-Saharan Africa. Environmental Research Letters 10(12): 125015.

Buhaug H, Nordkvelle J, Bernauer T, Böhmelt T, Brzoska M, Busby JW, Ciccone A, Fjelde H, Gartzke E, Gleditsch NP, Goldstone JA, Hegre H, Holtermann H, Koubi V, Link JSA, Link PM, Lujala P, O'Loughlin J, Raleigh C, Scheffran J, Schilling J, Smith TG, Theisen OM, Tol RSJ, Urdal H and Von Uexkull N. (2014). One effect to rule them all? A comment on climate and conflict. Climatic Change 127(3): 391–397.

Burrows K and Kinney PL. (2016). Exploring the Climate Change, Migration and Conflict Nexus. International journal of environmental research and public health 13(4): 443.

Carruthers D and Rodriguez P. (2009). Mapuche Protest, Environmental Conflict and Social Movement Linkage in Chile. Third World Quarterly 30(4): 743–760.

Cederman L-E and Weidmann NB. (2017). Predicting armed conflict: Time to adjust our expectations? Science 355(6324): 474–476.

Collier P. (2007). The Conflict Trap. Bottom billion. Why the Poorest Countries Are Failing and What Can Be Done About It. University Press, Oxford.

CORDAID (2015). Our Peace, Our Future. Experiences from community managed disaster risk reduction approaches in South Sudan.
De Azevedo RF, Miranda LE and Gomes LC. (2016). Contesting detrimental dams: a case study from southern Brazil. International Journal of River Basin Management 14(2): 205–217.
De Bruin S, Knoop J, Ligtvoet W and Visser H. (2018). Linking water security treaths to conflict. An exploration of pathways. PBL Netherlands Environmental Assessment Agency, The Hague.
De Stefano L, Duncan J, Dinar S, Stal K, Strzepek KM and Wolf AT. (2012). Climate change and the institutional resilience of international river basins. Journal of Peace Research 49(1): 193–209.
De Stefano L, Petersen-Perlman JD, Sproles EA, Eynard J and Wolf AT. (2017). Assessment of transboundary river basins for potential hydropolitical tensions. Global Environmental Change 45: 35–46.
Defence Intelligence Agency (2012). Global Water Security. Intelligence Community Assessment, Defence Intelligence Agency U.S.
Devlin C and Hendrix CS. (2014). Trends and triggers redux: Climate change, rainfall, and interstate conflict. Political Geography 43: 27–39.
Fearon JD and Laitin DD. (2003). Ethnicity, insurgency, and civil war. American political science review 97(01): 75–90.
Feitelson E and Tubi A. (2017). A main driver or an intermediate variable? Climate change, water and security in the Middle East. Global Environmental Change 44: 39–48.
Fjelde H and Von Uexkull N. (2012). Climate triggers: Rainfall anomalies, vulnerability and communal conflict in Sub-Saharan Africa. Political Geography 31(7): 444–453.
Gernaat DE, Bogaart PW, Van Vuuren DP, Biemans H and Niessink R. (2017). High-resolution assessment of global technical and economic hydropower potential. Nature Energy 2(10): 821.
Ghimire R, Ferreira S and Dorfman JH. (2015). Flood-Induced Displacement and Civil Conflict. World Development 66: 614–628.
Gleditsch NP. (2012). Whither the weather? Climate change and conflict. Journal of Peace Research 49(1): 3–9.
Global Migration Group (2014). Migration and Youth: Challenges and Opportunities J. Cortina, P. Taran and A. Raphael, United Nations CHilderen's Fund.
Goldstone JA, Bates RH, Epstein DL, Gurr TR, Lustik MB, Marshall MG, Ulfelder J and Woodward M. (2010). A Global Model for Forecasting Political Instability. American Journal of Political Science 54(1): 190–208.
Goodwin-Gill GS and McAdam J. (2017). UNHCR and climate change, disasters and displacement.
Government Office for Science (2011). Foresight. Migration and Global Environmental Change. London.
Hallegatte S, Bangalore M, Bonzanigo L, Fay M, Kane T, Narloch U, Rozenberg J, Treguer D and Vogt-Schilb A. (2016). Shock Waves: Managing the Impacts of Climate Change on Poverty, The World Bank.
Hammond M. (2013). The Grand Ethiopian Renaissance Dam and the Blue Nile: implications for transboundary water governance. Global Water Forum Discussion paper.
Hartmann B. (2010). Rethinking climate refugees and climate conflict: rhetoric, reality and the politics of policy discourse. Journal of International Development 22(2): 233–246.
Hegre H, Karlsen J, Nygård HM, Strand H and Urdal H. (2011). Predicting Armed Conflict, 2010–2050. International Studies Quarterly 57(2): 250–270.
Hsiang SM and Burke M. (2014). Climate, conflict, and social stability: what does the evidence say? Climatic Change 123(1): 39–55.
Hsiang SM, Meng KC and Cane MA (2011). Civil conflicts are associated with the global climate. Nature 476(7361): 438–441.
Hsiang SM, Miguel E and Burke M. (2013). Quantifying the influence of climate on human conflict. Science 341(6151).
Institute for Economics and Peace (2016). Global Peace Index 2016.
International Institute for Applied Systems Analysis (2016). SSP Database (Shared Socioeconomic Pathways), Version 1.1.
Ionesco D, Mokhnacheva D and Gemenne F. (2017). Atlas of Environmental Migration International Organisation for Migration.
IPCC (2014). Climate change 2014: Synthesis report, Contributions of Working Groups I, II and III to the IPCC Fifth Assessment Report, Summary for Policymakers. Intergovernmental Panel on Climate Change, Genève.
Kaufman D and Kraay A. (2015). Worldwide Governance Indicators, World Bank.
Kawachi I and Berkman L. (2000). Social cohesion, social capital, and health. Social epidemiology: 174–190.
King MD. (2015). The weaponization of water in Syria and Iraq. The Washington Quarterly 38(4): 153–169.

Kirchherr J, Charles KJ and Walton MJ. (2016). The interplay of activists and dam developers: the case of Myanmar's mega-dams. International Journal of Water Resources Development: 1–21.
Link M, Scheffran J and Ide T. (2016). Conflict and cooperation in the water-security nexus: a global comparative analysis of river basins under climate change. WIRE's Water 3: 495–515.
Link PM, Scheffran J and Ide T. (2016). Conflict and cooperation in the water-security nexus: a global comparative analysis of river basins under climate change. WIRES Water 3(4): 495.
Rüttinger L, Smith D, Stang G, Tänzler D and Vivekananda J. (2015). A New Climate for Peace: taking action on climate and fragility risks, Adelphi, International Alert, Woodrow Wilson International Center for Scholars, European Union Institute for Security Studies.
Marchiori L, Maystadt J-F and Schumacher I. (2012). The impact of weather anomalies on migration in Sub-Saharan Africa. Journal of Environmental Economics and Management 63(3): 355–374.
Martínez V and Castillo OL. (2016). The political ecology of hydropower: Social justice and conflict in Colombian hydroelectricity development. Energy Research & Social Science 22: 69–78.
Mastrandrea MD, Mach KJ, Plattner G-K, Edenhofer O, Stocker TF, Field CB, Ebi KL and Matschoss PR. (2011). The IPCC AR5 guidance note on consistent treatment of uncertainties: a common approach across the working groups. Climatic Change 108(4): 675.
Moench M. (2002). Water and the potential for social instability: Livelihoods, migration and the building of society. Natural Resources Forum 26(3): 195–204.
Moore D, Dore J and Gyawali D. (2010). The World Commission on Dams + 10: Revisiting the large dam controversy. Water Alternatives 3(2): 3–13.
Nett K and Rüttinger L. (2016). Insurgency, Terrorism and Organised Crime in a Warming Climate. Analysing the Links Between Climate Change and Non-State Armed Groups. Adelphi, Berlin.
Neumann B, Vafeidis AT, Zimmermann J and Nicholls RJ. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding – a global assessment. PloS one 10(3): e0118571.
Neumann K, Sietz D, Hilderink H, Janssen P, Kok M and Van Dijk H. (2015). Environmental drivers of human migration in drylands – A spatial picture. Applied Geography 56: 116–126.
Olsson L, Opondo M, Tschakert P, Agrawal A and Eriksen SE. (2014). Livelihoods and poverty. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge (UK) and New York, NY, Cambridge University Press.
PBL (2018). The geography of future water challenges. PBL Netherlands Assessment Agency, The Hague.
Rahaman MM. (2012). Water wars in 21st century: speculation or reality? International Journal of Sustainable Society 4(1–2): 3–10.
Raleigh C and Urdal H. (2007). Climate change, environmental degradation and armed conflict. Political Geography 26(6): 674–694.
Reuveny R. (2007). Climate-change-induced migration and violent conflict. Political Geography 26(6): 656–673.
Richards J-A and Bradshaw S. (2017). Uprooted by climate change. Oxfam briefing paper, Oxfam International.
Rigaud K. K. d. S., Alex, Jones B, Bergmann J, Clement V, Ober K, Schewe J, Adamo S, McCusker B, Heuser S, Midgley A. (2018). Groundswell : Preparing for Internal Climate Migration. World Bank, Washington D.C.
Robins NS and Fergusson J. (2014). Groundwater scarcity and conflict – managing hotspots. Earth Perspectives 1(1): 1–9.
Salehyan I and Hendrix CS. (2014). Climate shocks and political violence. Global Environmental Change 28: 239–250.
Selby J and Hoffmann C. (2012). Water Scarcity, Conflict, and Migration: A Comparative Analysis and Reappraisal. Environment and Planning C: Government and Policy 30(6): 997–1014.
Seto KC. (2011). Exploring the dynamics of migration to mega-delta cities in Asia and Africa: Contemporary drivers and future scenarios. Global Environmental Change 21, Supplement 1: S94–S107.
Smith TG. (2014). Feeding unrest. Journal of Peace Research 51(6): 679–695.
Stapleton SO, Nadin R, Watson C and Kellet J. (2017). Climate change, migration and displacement. Published online, United Nations Development Plan and Overseas Development Institute.
Straatsma M, Droogers P, Brandsma J, Buytaert W, Karssenberg D, Van Beek R, Wada Y, Sutanudjaja E, Vitolo C and Schmitz O. (2014). Bridging the climate-induced water gap in the twenty-first century: adaptation support based on water supply, demand, adaptation and financing. EGU General Assembly Conference Abstracts.

Tacoli C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. Environment and Urbanization 21(2): 513–525.
Temper L, d. Bene D, and Martinez-Alier J. (2015). Mapping the frontiers and front lines of global environmental justice: the EJAtlas. Journal of Political Ecology 22: 255–278.
The Guardian (2016). Disasters linked to climate can increase risk of armed conflict. Retrieved 03 May 2017, from https://www.theguardian.com/environment/2016/jul/25/disasters-linked-to-climate-can-increase-risk-of-armed-conflict.
Theisen OM, Gleditsch NP and Buhaug H. (2013). Is climate change a driver of armed conflict? Climatic Change 117(3): 613–625.
Transparency International (2017). What is corruption? Retrieved 28 December2017, from https://www.transparency.org/what-is-corruption#define.
Turner MD. (2004). Political ecology and the moral dimensions of resource conflicts: the case of farmer–herder conflicts in the Sahel. Political Geography 23(7): 863–889.
UNEP-DHI and UNEP (2016). Meta data sheet: hydropolitical tension. from http://twap-rivers.org/indicators/Report.ashx?type=IndicatorSheet&id=59fd960847634752af26af01850734b7.
UNEP-DHI and UNEP (2016). Transboundary River Basins – Status ans Trends – Summary for Policy Makers, UNEP, Nairobi.
UNHRC (2015). UNHCR, The Environment & Climate Change. V. Türk, S. Corliss, J. Riera et al. The UN High Commissioner for Refugees, Geneva.
United Nations Environmental Programme and Global Environmental Facility (2016). Transboundary Waters Assessment Programme River Basins.
Van Schaik L and Bakker T. (2017). Climate-migration-security: Making the most of a contested relationship. Clingendael, The Hague.
Visser H and De Bruin S. (2018). (Forthcoming) Planetary security: indicator-based analyses. PBL Netherlands Environmental Assessment Agency, The Hague.
Von Uexkull N. (2014). Sustained drought, vulnerability and civil conflict in Sub-Saharan Africa. Political Geography 43: 16–26.
Von Uexkull N, Croicu M, Fjelde H and Buhaug H. (2016). Civil conflict sensitivity to growing-season drought. Proceedings of the National Academy of Sciences 113(44): 12391–12396.
Wada Y, Van Beek LPH, Viviroli D, Dürr HH, Weingartner R and Bierkens MFP. (2011). Global monthly water stress: 2. Water demand and severity of water stress. Water Resources Research 47(7).
Walicki N, Ioannides M and Tilt B. (2017). Dams and Internal Displacement An Introduction. Dam Displacement. Case Study Series, Internal Displacement Monitoring Centre, Applied Social Analysis, Oregon State University.
Warnecke A, Tänzler D and Vollmer R. (2010). Climate Change, Migration and Conflict: Receiving Communities under Pressure? Climate Change and Mitigation, from https://www.bicc.de/uploads/tx_bicctools/gmf_climate-change-migration-conflict_07_2010.pdf.
Whittington D, Wu X and Sadoff C. (2005). Water resources management in the Nile basin: the economic value of cooperation. Water policy 7(3): 227–252.
Wilby RL and Keenan R. (2012). Adapting to flood risk under climate change. Progress in Physical Geography.
Wolf AT. (2001). Transboundary waters: Sharing benefits, lessons learned. International Conference on Freshwater (Hrsg.): Thematic Background Papers. International Conference on Freshwater, Bonn.
Wolf AT. (2007). Shared waters: Conflict and cooperation. Annu. Rev. Environ. Resour. 32: 241–269.
World Bank (2010). Agriculture, value added (% of GDP), World Bank, Washington D.C.
Zarfl C, Lumsdon AE, Berlekamp J, Tydecks L and Tockner K. (2015). A global boom in hydropower dam construction. Aquatic Sciences 77(1): 161–170.
Zeitoun M and Mirumachi N. (2008). Transboundary water interaction I: Reconsidering conflict and cooperation. International Environmental Agreements: Politics, Law and Economics 8(4): 297.

Appendix 1 local water-stress-related conflict

Conflict	Time frame	Source
Lower Mekong Basin: challenges and opportunities for early cooperation, water stress sparked a sense of urgency and crisis.	1957–1995	ECC Platform
The role of water resources in the Sudan-South Sudan Peace Process	2005–ongoing	ECC Platform
Climatic change, fragility and conflict in northern Mali	2012–ongoing	ECC Platform
Water shortages and public discontent in Yemen	2009–ongoing	ECC Platform
Security implications of growing water scarcity in Egypt	2013–ongoing	ECC Platform
Drought and conflict across the Kenyan-Ethiopian border	1944–ongoing	ECC Platform
Farmer-herder violence in the Tana River Delta, Kenya	2012–2013	ECC Platform
Local violence over water resources in Yemen	1990–ongoing	ECC Platform
Conflict between the Sa'ad and Suleiman of the Habar Gidir in Somalia	1991–ongoing	ECC Platform
Droughts, livestock prices and armed conflict in Somalia	2008–ongoing	ECC Platform
Water scarcity in northern China, causing grievances	1980–ongoing	ECC Platform
Climate change, charcoal trade and armed conflict in Somalia	2008–ongoing	ECC Platform
Iraq-Iran: from water dispute to war	1944–1988	ECC Platform
Israel-Palestine: water sharing conflict	1948–ongoing	ECC Platform
Turkey-Armenia: water cooperation despite tensions	1990–ongoing	ECC Platform
Syrian Civil War: the contested role of climate change	2011–ongoing	ECC Platform
Livelihood conflicts in the Ferghana Valley	1991–ongoing	ECC Platform
Water conflict over Acueducto Independencia in Mexico	2010–ongoing	ECC Platform
Communal conflicts across the Kenyan-Ugandan border	1944–ongoing	ECC Platform
Communal conflicts in the Karamoja Cluster (Uganda)	1944–ongoing	ECC Platform
Communal conflicts in the Karamoja Cluster (Kenya)	1944–ongoing	ECC Platform
Communal conflicts in the Karamoja region (South Sudan, Uganda, Kenya)	1944–ongoing	ECC Platform
Jabal Sabr Mountain water conflict in Yemen	1997–ongoing	ECC Platform
Tuareg rebellion in Niger: important droughts in the Sahel in the 1970s–1980s and subsequent migration of disaffected Tuaregs to Algeria and Libya arguably have played an important part in facilitating this conflict	1991–1997	ECC Platform
Tuareg rebellion in Mali: related to important droughts in the Sahel in the 1970s–1980s	1990–1995	ECC Platform
Tuareg rebellions in Mali and Niger in the 1990s	1990–1997. 2007–ongoing	ECC Platform
Farmer-herder conflict between Fulani and Zarma in Niger	1944–ongoing	ECC Platform
Interstate dispute over water in the Cauvery Basin in India	1974–ongoing	ECC Platform
Water conflict in the Indus River Basin between India and Pakistan affected by climate change and water use	1947–ongoing	ECC Platform
Civil war in Darfur, Sudan: droughts in the 1970s–1980s intensified clashes against different groups	2003–ongoing	ECC Platform
'Water coup' in Lesotho	1986	ECC Platform
Lake Chad, Africa – local conflicts over survival resources	1970–ongoing	ECC Platform
Droughts, migration and communal conflicts in Darfur	1980–ongoing	ECC Platform
Conflict between Habaniya and Reizegat Baggara in Sudan	2006	ECC Platform
Conflict related to spreading desertification and poor resource management between Falata and Habaniya in Darfur, Sudan	2006–2010	ECC Platform
Conflicts over water and land between the Awlad Zeid and Zaghawa in Sudan	1980–ongoing	ECC Platform
Conflicts between Didinga and Toposa over land, livestock and water in South Sudan	1944–2013	ECC Platform
Conflict between Jikany Nuer and Lou Nuer over land and access to water in South Sudan	1993–ongoing	ECC Platform
Conflicts, including those over land and water resources between Lou Nuer and Murle in South Sudan	1944–ongoing	ECC Platform

Conflicts over grazing land and water between Dinka and Nuer in South Sudan	1944–ongoing	ECC Platform
Communal conflicts related to detoriating environmental condistions, land, livestock and water in South Sudan	1944–ongoing	ECC Platform
Pastoralist and farmer-herder conflicts in the Sahel	1944–ongoing	ECC Platform
Conflict related to diminishing land and water resources between Masalit and Reizegat Abbala in Sudan	1944–1999	ECC Platform
Conflict over water in the Aral Sea	1991–ongoing	ECC Platform
Clashes over access to water in drought-hit Indian region	2016	https://everylifecounts. bundelkhand-1442
Water cuts in Tunesia cause social disruption after uprisings in 2011	2016	https://www.al- monitor.com/pulse/ru/ scarcity-crisis-protests
Riots over eratic water supply in Kitwe, Zambia	2014	https://www.daily-mail
Violent riots over water shortage in townships in South Africa	2014	http://www.bbc.com/n killed-at-protest-over-w
Tanzanian farmers and herders jostle for dwindling water resources	2013	http://www.ipsnews.ne
Border clashes Burkina Faso and Mali over water and land	2012	http://www.aljazeera.c
Demonstrations and clashes over water shortages in Algeria	2013	http://www.moroccowo arrested-over-water-ric
Iranian farmers clash with police over water rights	2013	http://www.thehindu.co police-over-water-right
Tribal clashes over the distribution of irrigation water in Pakistan	2010	https://tribune.com.pk/ dead/
Numerous local clashes over water in Burkina Faso	2007	http://www.irinnews.or education-needed-hea

Appendix 2 List of all countries where water could have played a role in conflict

(drought/water stress, land or land rights)

Country	GovernanceScaled		Country	GDP/cap
Israel	7.78		Israel	26.71
Rwanda	5.31		Turkey	12.54
South Africa	5.19		Mexico	12.43
China	5.06		Iran	10.95
Turkey	4.94		South Africa	9.47
India	4.69		Tunisia	8.56
Tunisia	4.44		Algeria	7.56
Philippines	4.32		China	6.80
Senegal	4.32		Egypt	5.54
Mexico	4.20		Armenia	4.90
Viet Nam	4.20		Syria	4.75
Armenia	3.95		Philippines	3.56
Burkina Faso	3.95		Iraq	3.23
Palestine	3.95		India	2.98
Lesotho	3.70		Uzbekistan	2.87
Zambia	3.70		Viet Nam	2.84
Algeria	3.58		Palestine	2.75
Iran	3.58		Pakistan	2.41
Niger	3.46		Yemen	2.37
Ethiopia	3.33		Mauritania	2.20
Kenya	3.33		Nigeria	2.13
Tanzania	3.33		Cameroon	2.06
Egypt	3.21		South Sudan	2.02
Pakistan	3.21		Sudan	2.02
Mali	2.96		Cambodia	1.97
Uganda	2.96		Senegal	1.74
Cameroon	2.72		Kenya	1.48
Nigeria	2.59		Lesotho	1.44
Cambodia	2.47		Zambia	1.38
Mauritania	2.47		Chad	1.34
Uzbekistan	2.47		Tanzania	1.25
Iraq	1.60		Uganda	1.15
Chad	1.48		Burkina Faso	1.14
Sudan	1.11		Rwanda	1.04
Syria	0.86		Mali	0.97
Yemen	0.86		Ethiopia	0.93
South Sudan	0.12		Niger	0.65
Somalia	0.00		Somalia	0.03

Appendix 3 Major conflicts related to dam construction

Violence in Mauritania and Senegal, the plan to build two large dams contributed to unrest	1989–1992	ECC factbook
Mekong River Basin: dam disputes	1995–ongoing	ECC factbook
Transboundary water disputes between Afghanistan and Iran	2001–ongoing	ECC factbook
Security implications related to the Gilgel Gibe III Dam, Ethiopia	2008–ongoing	ECC factbook
Numerous dams threaten indigenous livelihoods in the Brazilian Amazon	1980–ongoing	Env. Justice Atlas
Kariba Dam, Zambia/Zimbabwe—impoverishment of decendants of resettled people	1958–ongoing	Env. Justice Atlas
Xacbal hydropower project affecting local livelihoods, Guatemale	2014–ongoing	Env. Justice Atlas
Dispute over water in the Nile Basin	1944–ongoing	ECC factbook
Disputes over the Grand Ethiopian Renaissance Dam (GERD)	2011–ongoing	ECC factbook
Yarmouk River: both tensions and cooperation between Syria and Jordan	1948–ongoing	ECC factbook
Turkey, Syria and Iraq: conflict over the Tigris-Euphrates Basin	1960–ongoing	ECC factbook
Dam conflict between Kyrgyzstan and Uzbekistan	1980–ongoing	ECC factbook
Santa Rita Dam conflict in Guatemala	2010–ongoing	ECC factbook
China's plan to build dams in the Brahmaputra River have set off ripples of anxiety in India and Bangladesh	2015	Env. Justice Atlas
Akosombo hydropower project, Ghana, leaving farmers and villages without land	1961–ongoing	Env. Justice Atlas
Violent protests against the Hatgyi Dam in Myanmar	2009	ECC factbook
Salween River dam conflict in Myanmar	2013–ongoing	ECC factbook
Myitsone Dam conflict in Myanmar	2007–ongoing	ECC factbook
India and Bangladesh: conflict over the Ganges River	1957–ongoing	ECC factbook
Kalabagh Dam conflict in Pakistan	2004–2008	ECC factbook
Three Gorges Dam conflict in China	1994–ongoing	ECC factbook
Barro Blanco Dam conflict in Panama	2010–ongoing	ECC factbook
Sogamoso Dam, Colombia, caused displacement, land grabbing, militarisation	2009–ongoing	Env. Justice Atlas
Rogun Dam conflict between Tajikistan and Uzbekistan	1991–ongoing	ECC factbook
Sardar Sarovar Dam conflict in India	1985–ongoing	ECC factbook
Narmada Dam water disputes between Indian States	1961–1979	ECC factbook