Regions vulnerable to climate change

findings and methodological considerations

HANNES SONNSJÖ

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FOI-R--3308--SE
ISSN 1650-1942

Base data report
December 2011

Defence Analysis

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Cover photo: Fotoakuten

FOI-R- -3308--SE

Titel	Regioner särskilt sårbara för klimatförändringar – vilka pekas ut och på vilka grunder?
Title	Regions vulnerable to climate change – findings and methodological considerations
Rapportnr/Report no	FOI-R- -3308--SE
Rapporttyp Report Type	Underlagsrapport/Base data report
Månad/Month	December
Utgivningsår/Year	2011
Antal sidor/Pages	61 p
ISSN	ISSN 1650-1942
Kund/Customer	Försvarsdepartementet/Swedish Ministry of Defence
Projektnr/Project no	A12101
Godkänd av/Approved by	Eva Mittermaier

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Sammanfattning

Klimatförändringarnas effekter kommer inte att vara jämt fördelade över jordklotet. Ett flertal studier har därför försökt identifiera de regioner som kan förväntas vara särskilt sårbara eller uppvisa särskilt hög risk för konflikter till följd av klimatförändringarna (s.k. 'hotspots'). Föreliggande rapport syftar till att beskriva vilka regioner som har identifierats samt att analysera de utgångspunkter som har använts i studierna. I analysen har ett särskilt intresse riktats mot vilka effekter av klimatförändringarna som behandlas, vilka perspektiv på säkerhet som tas, vilket tidsperspektiv analysen anlägger samt hur samspelet mellan klimatförändringar och andra parallellt pågående förändringsprocesser införlivas. Analysen har strukturerats utifrån fyra övergripande teman: biofysisk utsatthet, socioekonomisk sårbarhet, miljöförstöring samt konflikthistoria. Sammantaget behandlas nio regioner i studierna: Arktis, sydöstra och östra Europa, södra medelhavsområdet, Sahelområdet, södra Afrika, sydvästra Asien, centrala Asien, östra Asien samt Sydamerika.

Regional analys

Arktis: Säkerhetskonsekvenserna i regionen kopplas främst till bristen på tydliga territoriella gränser och väldefinierade rättigheter för olika länder kring de naturtillgångar som tillgängliggörs i och med klimatförändringarna. Bristen på internationell reglering anses utgöra en risk för militarisering av intressekonflikter mellan olika stater.

Sydöstra och östra Europa: Säkerhetskonsekvenserna i regionen bottnar huvudsakligen i risken för en ekonomisk nedgång i två centrala men klimatkänsliga sektorer, nämligen turism och jordbruk. Detta anses kunna förvärra redan befintliga etniska spänningar i regionen, särskilt om omfattande migration blir följden av en negativ samhällsutveckling.

Södra medelhavsområdet: Säkerhetskonsekvenserna i regionen härleds huvudsakligen till ökad risk för vatten- och matbrist, militarisering av vattenkonflikter, ekonomisk nedgång och omfattande migration. Beroendet av importerad mat medför att åtskilliga länder i regionen är mycket känsliga för plötsliga prishöjningar vilket i sin tur anses kunna komma att ligga till grund för ett utspritt missnöje och väpnade upplopp.

Sahelområdet: Säkerhetskonsekvenserna i regionen uppfattas framförallt bottna i rådande sårbarheter och klimatförändringarna blir ytterligare en stor utmaning för denna region. En stor andel av befolkningen är beroende av export från bomull och djuruppfödning. Båda dessa områden är mycket känsliga för förändringar i nederbörd och temperatur.

Södra Afrika: Säkerhetskonsekvenserna i regionen kopplas främst till allvarlig vattenbrist vilket påverkar såväl jordbruket som människors hälsa och vardagsliv. En havsnivåhöjning betonas också som en säkerhetsrisk eftersom den hotar ett flertal stora kuststäder.

Sydvästra Asien: Säkerhetskonsekvenserna i regionen är främst kopplade till vatten- och matbrist å ena sidan och socioekonomisk sårbarhet å andra sidan, främst vad gäller ekonomisk nedgång och stagnation i oljerika länder.

Centrala Asien: Säkerhetskonsekvenserna i regionen knyts framförallt till riskerna för intressekonflikter mellan den del av befolkningen som använder vatten för elproduktion i vattenkraftverk och den del som främst använder vatten för bevattning inom jordbruket. Eftersom en stor andel av befolkningen är anställda inom jordbruket är denna sektor särskilt känslig för klimatförändringarnas effekter. Det post-sovjetiska arvet anses också hindra utvecklingen och effektiviseringen av viktiga institutioner i regionen.

Östra Asien: Säkerhetskonsekvenserna i regionen är främst relaterade till havsnivåhöjningen, vilken påverkar åtskilliga miljoner människor boendes längs kusten, och till förändringarna av nederbörd och tid för monsun, vilka påverkar både jordbruksproduktionen och risken för översvämningar. Dessa förändringar i kombination med en ökad risk för extrema väderhändelser anses utgöra en särskilt risk för kustområdena, vilka också innehar åtskilliga stora städer.

Sydamerika: Säkerhetskonsekvenserna i regionen av klimatförändringarna anses främst vara sprungna ur bristen på politisk insikt i behovet av klimatanpassning vad gäller risken för vattenbrist och i behovet att reducera pågående miljöförstöring och skövling av regnskog. En okontrollerad urbanisering gör även att många stora städer förväntas vara särskilt sårbara för klimatförändringarnas effekter.

Summering

De säkerhetskonsekvenser som identifierats i de analyserade studierna visar på olika risker kopplade till klimatförändringarna, såsom vattenbrist, störningar i livsmedelsförsörjningen och havsnivåhöjning, liksom till betydelsen av det samspel som finns mellan olika förändringsprocesser. De metodansatser som används i studierna kan särskiljas mellan dem som utgår från biofysisk utsatthet, dvs. från klimatförändringarnas effekter, och dem som tar utgångspunkt i befintliga sårbarheter, vilka klimatförändringarna kan förstärka. Tendensen att välja *en* av dessa ansatser ligger till grund för att poängtera att klimatförändringarnas säkerhetskonsekvenser bottnar i en kombination av båda dessa faktorer och att konsekvenserna således är ett resultat av biofysisk utsatthet *i kombination med* hög grad av sårbarhet och svag anpassningskapacitet. Det är också viktigt att beakta vilka perspektiv på säkerhet som ligger till grund för analys. Härvidlag brister många studier i transparens.

Att utveckla bättre förståelse för komplexiteten bakom klimatförändringarnas säkerhetskonsekvenser är en viktig uppgift i vilket lokala förutsättningar och villkor utgör viktiga utgångspunkter. Härvidlag måste utgångspunkten tas i att det inte enbart är klimatet som förändras utan även samhällen och dess förmåga att anpassa sig förändras.

Nyckelord: klimatförändringar, säkerhet, konflikt, hotspot, sårbarhet, miljöförstöring

Summary

The impacts of climate change will not be evenly spread around the globe. Instead, several studies point to some specific regions that are argued to be particularly vulnerable or prone to climate change-related conflict ('hotspots') The overarching aim of this report is to describe these regions and to look at the underlying methodology used by those studies when identifying the regional 'hotspots.' Special attention is paid to the specific impacts of climate change that the studies considered, which security approaches they adopted, the time-frames or climate scenarios used and whether there are additional transformation processes or converging trends. The analysis is structured on four general themes: biophysical exposure, environmental degradation, socio-economic vulnerabilities and history of violence. In sum, based on their respective security implications deriving from the impacts of climate change, the resulting nine regions are examined: the Arctic, South-East & Eastern Europe, the Southern Mediterranean, the Sahel zone, Southern Africa, South-West Asia, Central Asia, East Asia, and South America.

Regional analysis

The Arctic: Security implications for the region are primarily found in the lack of clear territorial boundaries and user rights for the extraction of previously hidden resources, and the risk of a militarization of the disputes due to the conflicting interests of powerful states.

South-East and Eastern Europe: Security implications for the region are primarily found in the potential for economic deterioration, since two important sectors – tourism and agriculture – are highly climate-sensitive. This could exacerbate existing ethno-political tension, as some parts of the population are forced to migrate as a result of e.g. food insecurity. The proximity to the European Union is often emphasised as an important factor for recognising the region as a hotspot.

Southern Mediterranean: Security implications for the region are mainly found in shortages of water and food, the militarisation of water disputes, displacement of large populations and economic stagnation. The dependence on food imports make several of the countries in the region vulnerable to price hikes, which in turn could lead to civil unrest and riots. An area recognised as particularly prone to security risks is the Nile Delta, due to the number of bordering states and the population density along the river.

Sahel zone: Security implications for the region are found in the prevailing socio-economic vulnerability, where climate change will be an additional factor and a multiplier. From a human security point of view, a large proportion of the population living in the region are dependent on exports from cotton and cattle-rearing which are both sensitive to changes in precipitation and temperature.

Southern Africa: Security implications for the region are mainly the result of severe water stress affecting human security and well-being. There is also risk resulting from sea-level rise, since in coastal areas there are several large cities.

South-West Asia: Security implications for the region are found in water and food shortages, and in socio-economic vulnerabilities, mainly the economic decline and stagnation even in resource-rich countries.

Central Asia: Security implications for the region could come from both socio-economic vulnerabilities, where a large proportion of the population is employed in climate-sensitive agriculture, as well as tensions between actors with conflicting interests regarding water use, such as for electricity production and irrigation. A post-Soviet legacy, experienced as a lack of institutional legitimacy and trust, also hampers the development of adaptive capacity in a number of the countries.

East Asia: Security implications for the region are found in a wide range of challenges; for example, the expected sea level rise will threaten the dwellings of millions, while changes in the monsoon and a greater seasonal variability in precipitation would result in both droughts and heavy rainfall.

South America: Security implications for the region are found in weak governmental capacity for managing and coping with water stress, soil degradation and the deforestation of Amazonas. A converging trend that exacerbates these challenges is rapid urbanisation due to heavy migration into several of the region's cities.

Conclusions

The security implications identified in the studies examined in this report are connected to several impacts of climate change, such as water stress, food insecurity and sea-level rise. Many of the studies acknowledge that the interplay between climate change and additional transformation processes are also an important security risk. Regarding the methodological approaches of the studies, an important distinction can be drawn between impact-driven analysis that emphasises biophysical exposure, on the one hand, and vulnerability-driven analysis that emphasises socio-economic factors, on the other. The tendency to focus solely on only *one* of those two approaches is an aspect that is often overlooked in the studies; doing so misses the realization that security implications due to climate change are often the result of a biophysical exposure *in combination with* a weak societal capacity to adapt. Although it is important to understand the impacts of future climate change, it is equally important to acknowledge that societies also develop and change. Both need to be part of any analysis.

Keywords: climate change, security, conflict, hotspot, vulnerability, environmental degradation

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Abbreviations

ACIA – The Arctic Climate Impact Assessment

CILSS – Comité Inter-Etats de Lutte contre la Sécheresse dans le Sahel

CO_2 – Carbon dioxide

EEZ – Exclusive Economic Zone

ENVSEC – The Environment and Security Initiative

EU – European Union

GCC – Gulf Cooperation Council

GDP – Gross Domestic Product

GTZ – German Agency for Technical Cooperation (Gesellschaft für Technische Zusammenarbeit)

IISS – The International Institute for Strategic Studies

IMO – International Maritime Organization

IPCC – Intergovernmental Panel on Climate Change

MoD – Ministry of Defence

NATO – North Atlantic Treaty Organization

NIC – National Intelligence Council

OSCE – Organization for Security and Co-operation in Europe

SRES – Special Report in Emissions Scenarios

U.K. – The United Kingdom

U.S. – The United States of America

UN – United Nations

UNCLOS – United Nations Convention of the Law Of the Sea

UNDP – United Nations Development Programme

UNEP – United Nations Environment Programme

WBGU – German Advisory Council on Global Change (Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen)

Preface

This report is produced as part of a project orientated towards analysing the security consequences of climate change. The project is funded by the Swedish Ministry of Defence and conducted by the Swedish Defence Research Agency, FOI. During 2011, the focus has been to conduct an analysis of which regions are considered to be particularly vulnerable to the effects of climate change, as well as the security consequences that might follow. This analysis has a dual aim; first, an examination of which regions are recognised as particularly vulnerable to climate change and, second, an analysis of the methodological approaches used in the studies identifying these regions. The importance of the methodological approaches and their implications for the analysis was identified in the investigations conducted during 2010; that recognition is regarded as a crucial step in improving the adequacy of risk analysis in assessing the security consequences posed by climate change.

In preparing this report, we received input from a number of people. Bengt Johansson, FOI, has continuously provided valuable comments. Participants at a seminar held at FOI in October, 2011, also contributed helpful advice. We are also grateful to our commentator, Richard Langlais, of FOI and Lund University, who conducted a critical review of one of the final stages of the resulting report. Heidi Askenlöv has been helpful in assisting us with the layout. Any remaining errors in the text are the responsibility of the author.

Project leader

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1 Introduction

The effects of climate change are already evident in several parts of the world. As reported by the Intergovernmental Panel on Climate Change (IPCC), glaciers are melting, deserts are spreading and coastal areas are being lost due to sea level rise.[1] Unabated climate change could threaten biodiversity and lead to vast impacts on the ecosystem services needed for human well-being, such as freshwater and arable land for food production.[2]

One particular dire consequence of climate change on human societies, as acknowledged by IPCC in its Fourth Assessment Report, is the occurrence of conflicts in specific vulnerable regions.[3] By triggering a cycle of environmental degradation, economic decline, social unrest and political instability, climate change may become a crucial issue for future conflict and has therefore been identified as one of the key challenges of our time.[4] However, the effects of climate change interplay with other transformation processes and will thus lead to substantially different consequences for different societies. It is therefore important to understand that vulnerability with regard to the impacts of climate change is a function of biophysical exposure (e.g. low-lying coastal countries suffering from sea level rise) *in combination* with a weak capacity to adapt and respond to those changes (e.g. lack of early warning systems or weak institutions to manage resources).[5]

The occurrence of conflict in connection with climate change also has an effect on how security is perceived. Framing climate change as a security risk is not a straightforward process and due to the indirect and complex linkages it has grown to become a contested scientific field.[6] Furthermore, it is not clear whether the threats posed by climate change are a matter of 'hard' and state-centric security directives, or whether security consequences presuppose a broadening of the security concept to incorporate the aspect of human security. Instead of posing this either-or approach, a number of scholars now stress the importance of acknowledging that the different security approaches are interconnected and complementary, since security risks on individual level may have spill-over effects onto the state level and *vice versa*, not least through indirect socio-economic or political factors. This calls for the necessity to include different

[1] IPCC 2007a
[2] Millennium Ecosystem Assessment 2005
[3] IPCC 2007a
[4] European Commission 2008; NIC 2008; UK MoD 2008
[5] Barnett 2006
[6] Mobjörk et al. 2010; Salehyan 2008

transformation processes when analysing the security implications from climate change.[7]

A central premise underlies the aim and findings of this report. The impacts of climate change will not be evenly spread around the globe. Looking at regions where the security implications of climate change are more severe ('hotspots') than in other regions may provide in-depth knowledge on specific vulnerabilities, but an even more focal point in this report is to analyse the methodology used for identifying these regions. Nonetheless, as argued in previous reports from FOI on the connection between climate change and conflict, these linkages are complex and there are important considerations to be made by those conducting studies on regional vulnerabilities.[8]

1.1 Aim and guiding research questions

Proceeding from the above premise, the overarching aim of this report is to *describe the regions recognised as particularly vulnerable or prone to security implications due to climate change*, and to look at *the underlying methodology used when identifying these regional 'hotspots'*.

Four guiding research questions are considered in examining nine published studies that identify hotspots and regions that are particularly vulnerable to climate change:

- What specific impacts of climate change are concerned in the analysis of climate change and security?
- What time-frames and climate scenarios are used as a basis for the impact analysis?
- What security implications are addressed and what arguments are provided for the link between these implications and climate change?
- What other aspects are taken into consideration in terms of additional transformation processes or converging trends – globally and regional – as well as the security approach adopted?

1.2 Methods and materials

Following the aim to describe regions recognised as particularly vulnerable to climate change as well as analysing the methodology used in a collection of studies, this report builds upon a critical literature review. For that purpose an

[7] Foresight 2011a; Mobjörk et al. 2010
[8] Mobjörk et al. 2010, Johansson 2010

analytical framework was constructed, which allowed several important aspects to be highlighted and a number of differences in lines of argument to be more easily visualised. The framework consists of four themes, or categories, used in order to structure the reasoning among the authors of the studies included in the analysis. The themes (biophysical exposure, environmental degradation, socio-economic vulnerabilities and history of violence) are all closely connected to the four research questions presented above with an emphasis on the third question regarding how the link between climate change and security implications is established, as this is the overarching aim of this report.

The studies included in this report are the result of a strategic selection where they share at least four common features. First, they are desk-based in the sense that no data were collected from the field. Instead, they are grounded upon the involvements of experts and by synthesising prevalent research where potential security implications are analysed from a wide range of sources. The studies are also often policy-orientated and published by either government ministries or research centres working on behalf of political organisations, such as the European Commission or the Organization for Security and Co-Operation in Europe (OSCE).

Second, they do not focus solely on one specific region and rarely provide any high-resolution analysis on national or sub-national characteristics such as rainfall patterns, or potential key actors such as political groups or civil society.

Third, the studies emphasise a wide range of potential security threats such as migration or access to natural resources, instead of narrowing the analysis down to focus solely on one category.

Lastly, the driver for conflict emphasised in the studies is climate change and environmental degradation resulting from such change. Hence, studies that focus solely on non-climate causes, such as toxic waste or oil spills, were consciously excluded from the analysis.[9]

In sum, the nine studies that were selected are described briefly below with a focus on the client commissioning the study.

Carius et al. (2009): ***Climate Change and Security – Three Scenarios for South West Asia***
This study was co-authored by analysts at Adelphi Research and was prepared for the Directorate General External Relations of the European Commission. The report concludes with specific recommendations for the Commission in its future work on development within the region.

Carius et al. (2008): ***Climate Change and Security***

[9] Altogether this led to the exclusion of otherwise interesting studies (see e.g. EU 2009; Ruckstuhl 2009; ENVSEC 2003; 2007)

The German Agency for Technical Cooperation (GTZ) is a federal enterprise tasked with providing services to several German government ministries regarding economic development and sustainability. This study was conducted by a collective from Adelphi Research and was commissioned by the Federal Ministry of Economic Cooperation and Development in order to highlight future challenges for that ministry.

IISS (2011): ***The IISS Transatlantic Dialogue on Climate Change and Security***
The International Institute for Strategic Studies (IISS) is a company based in the United Kingdom with a mission statement to influence and promote 'sound policies' within the area of international relations and security studies. This study was carried out for the European Commission as an attempt to promote cooperation between Europe and the United States on climate security.

Lee (2009): ***Climate Change and Armed Conflict***
As part of the Routledge Studies on Peace and Conflict Resolution, this book attempts to visualise future trends regarding the relationship between climate change and conflict. Lee is a professor at the American University in Washington DC specialising in theories of international relations and as a result the book mainly concerns possible responses from international institutions and states in terms of the exploitation of new resources and competition over those that are scarce.

Maas et al. (2010): ***Shifting Bases, Shifting Perils***
This report was commissioned by the Co-ordinator of OSCE Economic and Environmental Activities, and the main focus within the study is on the EU and surrounding areas. It was carried out as a joint project by eight researchers at different centres (Adelphi in Germany, Chatham House in The U.K. and Cimera in Geneva). The main focus of the study is to map the security implications of climate change in several regions.

Messer (2010): ***Climate Change and Violent Conflict – A Critical Literature Review***
This study was published by Oxfam America, a U.S.-based organisation whose focus is on poverty reduction and international relief in development. As part of a larger series, the study is an attempt to address the aspects of climate change and human security without looking deeply into specific regional impacts.

Schubert et al. (2008): ***Climate Change as a Security Risk***
This book was released by the German Advisory Council on Global Change (WBGU) and is an attempt to identify hotspots for climate-induced conflict and to present recommendations for action among policymakers. The analysis starts with a focus on specific biophysical vulnerabilities, which is then complemented with a socio-political dimension to highlight potential security risks. This

analysis ends up in several climate-induced conflict constellations being used when identifying regional hotspots.

U.K. Ministry of Defence (2010): ***Global Strategic Trends – Out to 2040***
The United Kingdom's Ministry of Defence (MoD) continually releases reports within its Global Strategic Trends Programme, which provides knowledge to the defence community. In this latest version climate change, along with three additional factors, is seen as a 'ring road issue', which implies that it is a driver for change with the potential to affect the lives of everyone on the planet. The study focuses less on regions and more on specific themes and topics, especially from a state-centric security perspective, where food and water are identified as particular 'hot topics'.

U.S. National Intelligence Council (2008): ***Global Trends 2025: A Transformed World***
The National Intelligence Council (NIC) provides the President of the United States, as well as senior policymakers, with analyses of foreign policy issues and is part of the strategic thinking within the government structure. By identifying certain important trends, this study is aims to encourage strategic thinking for planning the future up to the year 2025. Climate change is identified as one of the factors that will have a disproportionate influence on future events, especially in terms of food and water insecurity.

1.3 Structure of the report

The next section provides a brief theoretical discussion on the linkages between climate change, security and conflict. This forms the foundation for the analytical framework which guided the analysis of studies and the description of regions. In Chapter 3 the nine studies included are analysed in terms of the regions conceived as particularly vulnerable to climate change or 'hotspots' for climate change-related conflicts. Chapter 4 consists of methodological considerations on how the different studies frame climate change as a security risk as well as the specific vulnerabilities that are recognised in the different regions.

2 Climate change, security and conflict

Climate change concerns a great variety of physical processes such as temperature change, changes in precipitation, sea level rise, glacier melt and thawing of permafrost. These have different impacts, e.g. drought, flooding and erosion, which in turn are highly dependent on a multitude of additional factors, both physical, such as geographical location, and political or social, such as adaptive capacity. Furthermore, climate change interacts with other transformation processes such as environmental degradation, deforestation and socio-economic factors that may – depending on the context – reinforce or delimit the impacts following from climate change. This chapter describes general aspects of the connection between the effects of climate change on the one hand and the potential security implications or conflict risks following these on the other. These aspects act as the foundation for the analytical framework presented in the final section of this chapter.

2.1 The impacts of climate change

A crucial aspect as regards climate change and its impacts is the temporal scale or time-frame adopted. The six different scenarios in the Special Report in Emissions (SRES)[10] provided by IPCC, upon which much of the literature on climate change and conflict is based, show a wide range of outcomes, not least when adopting a longer time-frame such as the year 2100. A longer the time-frame is necessary in order to portray larger differences between the SRES-scenarios. For example, the assumed change in global temperature in the year 2030 ranges between 0.5-1.8^{o}C in the different scenarios, while the range in year 2100 is 1.1-6.4^{o}C.[11] The SRES-scenarios also include large differences concerning sea level rise which ranges between 0.2-0.6 metres by 2100, even without future rapid changes in ice melt which will have great impact on the magnitude of sea-level rise.[12]

An additional aspect closely connected with the temporal scale of climate change and the ability to adapt is the importance of speed and the magnitude of climate events. A truism in contemporary climate change research is that the faster the rate of change, the less time there is to adapt.[13] Thus, a distinction should be made between *gradual* climate change and *sudden* events, since these may have

[10] A1FI, A1B, A1, A2, B1, B2
[11] IPCC 2007b. Relative to the period 1980-1999
[12] Ibid.
[13] Barnett 2003:8

different security implications in terms of direct and indirect effects which call for different adaptive responses.

To begin with, gradual changes can have different characteristics. One important gradual climate change concerns the alterations in precipitation patterns whereby some areas of the world will have an excess of water (causing e.g. floods and landslides), whereas other areas will suffer from severe drought and aridity.[14] Some areas may even suffer from both, due to much greater seasonal differences as a result of climate change. Research on the climate change and security nexus has hitherto mainly encompassed gradual alterations of natural resources, especially in terms of *water* scarcity and *food* insecurity.[15]

The security consequences of alterations in water are complex. In a shorter time perspective, water availability could increase in those areas dependent on melt water from surrounding glaciers, but as the snow-covered areas decline and more precipitation falls as rain, instead of snow, due to a rise in temperature, in a longer time frame future water stress is to be expected in these areas. In terms of security risks, research on water management, particularly in shared river basins, has shown that cooperation is a common outcome between countries with shared river basins and in water-scarce areas.[16] Within countries, however, water scarcity could result in tensions and localised violence, even though it is seldom correlated with regular warfare.[17]

A gradual climate change will not only have impacts on water accessibility, but also on food production and regional stability. As shown in a recent article regarding the influence of the weather phenomenon El Niño on violent conflict,[18] as well as in a newly published report regarding the connection between food crises and political instability,[19] agriculture could play a crucial part in the outbreak of conflict due to both the dependency of farmers' livelihood on it, as well as the distributional and institutional problems that become visible in times of crisis.[20] Food production is closely connected to land management and as a result, some of the literature on the security implications following gradual change in precipitation and air temperature focuses on changes in land use due to the decline in agricultural yield.[21] IPCC therefore stresses that proper land management will be crucial in order to protect the biosphere in several regions,

[14] IPCC 2007a:179
[15] Mobjörk et al. 2010
[16] Gleditsch et al. 2006; Wolf 2007
[17] Wolf 2007
[18] Hsiang et al. 2011
[19] Lagi et al. 2011
[20] An often overlooked aspect regarding impacts of climate change and food production is that on fishery and aquaculture
[21] See e.g. Ruckstuhl 2009; EU 2009

since the most common way to cope with the increased demand in arable land has been in the clearing of marginal land and forests.[22]

A potential decline in food production may highlight the complex and intertwined relationships between human security, with the loss of livelihood and hunger among individuals on the one hand, and a state-centric approach on the other, where a nation's whole economic development and wealth may depend on agriculture.

The second process of climate change is sudden in its character and is portrayed most prominently by *extreme weather events*, such as heat waves, flooding, hurricanes and tropical cyclones. These events may have direct security implications, both from the impacts the events has on human life and from, for instance, the loss of territory due to rapid erosion which is increased by sea level rise. The impacts of these sudden events are worsened by at least two converging trends. As the demand for arable land continues, land use is altered e.g. due to deforestation, which greatly increases the risk of flooding. The second activity affecting vulnerability to extreme weather events is (rapid) urbanisation. A number of megacities and deltas lie in low-elevation coastal zones (e.g. Beijing, Cairo, Calcutta, Dhaka and Tokyo) and a great proportion of the world's population live in coastal areas, which is why these areas are expected to become "hotspots for vulnerability"[23], both with respect to extreme weather events and sea level rise. However, most attention in the literature has hitherto been given to gradual climate change.

Besides the interest in the interactions between climate change and security regarding water and food scarcities, there is also major interest in migration. The implications of climate change on migration are inherently complex and arguing that migration has implications for conflict is highly contested, both in terms of why and how climate change affects migration and regarding the role migration has in triggering conflicts. It is important to bear in mind that migration is an ancient and still-relevant coping strategy by which people handle for instance a gradual decline in agricultural yield or loss of livelihood.[24] Migration is also to a large extent based upon individual decision, although affected or reinforced by surrounding preconditions.

Slow-onset changes, e.g. gradual degradation in natural resources, and sudden-onset events, e.g. weather-related disasters, both influence migration, but in different ways. Research has shown that sudden-onset events most likely involve a temporary migration flow in the neighbouring area, while slow-onset events involve circular movements or permanent migration. Most of this migration is

[22] IPCC 2007a:94
[23] IPCC 2007a:327; World Development Report 2010:91ff
[24] Reuveny 2007; Brown 2007; McLeman 2011

internal and consists of rural-urban migration.[25] Nevertheless, those patterns identified throughout history seem to be in a process of alteration, which may be explained by the globalised economy and people's more widespread social networks around the world. However, it is crucial to remember that migration requires social and economic capital. Those left behind are hence the most vulnerable.[26]

Despite the dubious connections sometimes made between climate change, migration and conflict, it must also be acknowledged that large-scale movements, even for example those indirectly caused by climate change, may have security implications. These implications first and foremost concern the individual migrant, but can also reinforce societal stress. The connection between migration and conflict are thus of a similar character as those between climate change and conflict; they are indirect and the critical factor concerns a society's capacity to deal with change. Hence conflicts do not come about in isolation, but instead are utterly dependent on the social and political context.

2.2 An analytical framework

When addressing the linkage between climate change and conflict, one basic proposition can be outlined, i.e. there is no evidence for a straightforward or causal link between the two. Instead, climate change has implications for a large set of areas, which in turn interplay with other factors – political, social, economic – influencing conflicts. However, no single factor can be outlined as more important than any other as the cause for conflicts.

Furthermore, an analysis of the implications of climate change on security is dependent on the security approach applied. Adopting a human security approach may help identify potential threats to human livelihood. Since these in turn are dependent on a wide range of coping mechanisms such as poverty reduction, education and institutional capacity, society can develop more or less adaptive capacity. However, the human security approach is also linked to state security, as a society with large inequalities and large groups of vulnerable or insecure people is more prone to conflict. As such, the security concepts are intertwined, but the approach chosen affects what is predominantly considered a threat towards security, which also has implications for the policy responses developed.

The focus of this report is to better understand those regions that have been identified, in a number of studies, as vulnerable to climate change, and to consider the methodology used when identifying these regions. Hence, an important part is to consider the impacts of climate change analysed in the different studies examined and the climate scenarios used, as well as the security

[25] See e.g. Reuveny 2007; Brown 2007; McLeman 2011; Foresight 2011b
[26] Foresight 2011b

implications forecast. In order to provide a structured and comprehensive analysis of the regions that were identified in the studies, an analytical framework was developed based on four themes that span the complex web linking climate change to security and conflict. For each theme, examples of pivotal questions that were of particular interest in the analysis are listed:

Biophysical Exposure: What impacts of climate change are considered, for example in terms of gradual change or sudden extreme events? What climate scenario is used? What temporal scale is adopted? Is there a unique geographical setting for the analysis (e.g. coast, mountain or flood delta)?

Environmental Degradation: Are there any non-climate factors, such as various human activities, that directly or indirectly aggravate the environmental problems (e.g. soil degradation)? How will climate change affect environmental degradation – is climate change considered to result in this degradation or is it merely a multiplier of existing problems of environmental degradation? How are important ecosystems protected and what natural resources are extracted in the region?

Socio-economic Vulnerabilities: Is the population dependent on agriculture for its livelihood (human security) and does the agricultural sector represent a large proportion of a country's GDP (state security)? Are the different sectors in a country competing over scarce resources (e.g. hydropower versus irrigation needs)? Is the region experiencing rapid urbanisation or other forms of large-scale migration? How strong is the rule of law and are institutions functioning well in terms of adaptive capacity?

History of Violence: Is there a colonial legacy that could hamper development in the region? Is there a history of ethnic or political tension that could exacerbate conflict in times of crisis?

A comprehensive picture of conflict-prone regions should, in a structured and transparent way, incorporate all of these aspects. When that analysis is in place, even if the relation between the degree of being prone to conflict and the implications for security remain indirect, it should be possible to understand more about the impact that climate change has on the security of those regions.

Furthermore, it is important to stress that it is not only climate that will change, but also societies. This becomes critical when identifying for instance socio-economic vulnerabilities, since adaptive capacity is dependent not only on the speed and scale of climate change (biophysical exposure), but also on the preparedness and capacity of societies to cope with the impacts.

3 Regional analysis of hotspots – vulnerability and security implications

This chapter focuses on hotspots and regions identified as being particularly vulnerable for climate-induced conflict, both in terms of socio-economic factors and biophysical exposure to the effects of climate change. The reason for identifying a certain region as a hotspot varies between the different studies, but there is a high degree of consensus regarding which regions that are particularly vulnerable. The reason could be that the region comprises several failed states with weak governments, or that the inhabitants of a specific region share an important natural resource such as a river, or even that one individual country could destabilise the neighbouring countries in a region through certain 'spill-over' effects.

The regions included in this chapter are covered in all of the studies analysed in this report, although to a greater or lesser extent. The name and range of the region could differ somewhat between the studies which is why each chapter starts with a short clarification on which studies are being used as well a visual overview of the countries included. The main selection of regions is based on the identification of hotspots in each of the nine studies, which is the reason why certain countries omitted in the studies, such as Russia, were also left out in this report.

The purpose of this chapter is twofold. First and foremost, it provides an overview of the nine vulnerable and exposed regions that have been identified as hotspots in earlier studies. The chapter is divided into ten sub-chapters. The first nine comprehends the regions outlined in the analysed studies and compromises the Arctic, South-East and Eastern Europe, the Southern Mediterranean, the Sahel zone, Southern Africa, South-West Asia, Central Asia, East Asia, and South America. Each region is briefly described in terms of the expected impacts of climate change, as well as socio-economic and political preconditions. This is followed by an analysis of the security implications and case-specific vulnerabilities identified in each region.

3.1 The Arctic

3.1.1 The impacts of climate change on the region

The Arctic, geographically defined as the region north of the Polar Circle, is being seriously affected by climate change. IPCC reported an increase in air temperature during the 20th century of 5°C and for several decades the warming has been twice the global average[27]. A direct effect of this climate change can be seen in the reduction of the Arctic sea ice and the decline of glaciers. While the speed at which the ice sheets are melting differs in the literature, an estimate is provided by IPCC, as presented in Figure 3.1.1 below.

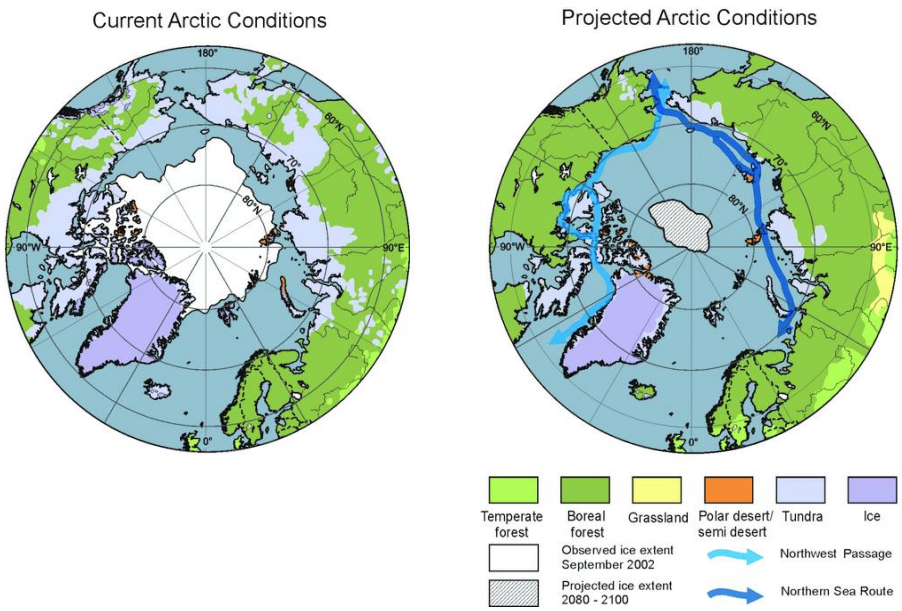


Figure 3.1.1. Map of current and projected Arctic conditions (year 2080-2100). Source IPCC (2007a).

[27] IPCC 2007a:656

The decline in glaciers and snow-covered areas could not only be seen as an *effect*, but also an interconnected *cause*, of future climate change. Since snow, ice and vegetation have the capacity to reflect some solar radiation due to the albedo effect, surface coverage by these mitigates the greenhouse effect causing global warming.[28] Hence, the reduction in the Arctic sea ice is an example of a direct regional impact that could have global implications, even though the predictions from IPCC on the exact effects are uncertain.[29]

Climate change will have a vast negative effect on biodiversity and wildlife in the Arctic region, but it will also have an impact on the approximately 4 million people living in that region. The most obvious effect will be the loss of current livelihood that is likely to occur as fish stocks decline, availability of freshwater is distorted and access to terrestrial resources such as reindeer, migratory birds and various crops diminish.[30] Potential benefits from a warmer climate are described more seldom, however, even though there are examples. The Arctic Climate Impact Assessment (ACIA) briefly mentions that some communities that fish for cod in the Arctic region "may see benefits from climate change if fish stocks increase"[31]. However, the likelihood of the stocks actually increasing is not proven and, as the ACIA authors themselves point out, their analysis is based on case studies which focus more on the negative impacts of climate change.[32]

There are also concerns that climate change will threaten important economic activities by causing severe damage to strategic harbours through coastal erosion and increased wave activity (which is already being observed along the northern coastline of Alaska), as well as a loss of important roads for land transport (as the thawing of permafrost increases).[33] On the other hand, climate change could also have positive implications such as the opening of new trade routes and access to valuable resources. As discussed in the next section, these new opportunities need to be well managed in order to be beneficial.

3.1.2 Vulnerabilities and security implications

The security risks posed by climate change in the Arctic have gained wide recognition, which is confirmed by the major focus that the region is given in several of the studies analysed here. Our overall analysis of the region is mainly based on three studies,[34] all of which identify melting of the Arctic ice as a main contributor to insecurity in at least two ways; the availability of previously

[28] See e.g. IPCC 2007a:663; Akbari et al. 2009
[29] IPCC 2007a:661
[30] IPCC 2007a:664ff
[31] ACIA 2005:63
[32] Ibid.
[33] ACIA 2005:929
[34] Lee 2009; Maas et al. 2010; Schubert et al. 2008

hidden natural resources and the accessibility of new trade routes. The security implications of these are dealt with below.

Extraction of non-renewable natural resources and territorial claims

The retreat of ice belts and glaciers will reveal a vast reserve of fossil fuels such as oil and gas, but also of other resources such as iron, nickel, diamonds and gold.[35] Estimates vary but according to an article published by researchers from the U.S. Geological Survey, as much as 13 per cent of the world's undiscovered petroleum reserves and 30 per cent of natural gas reserves could be located in the Arctic region.[36] The extraction of these resources can lead to an increased risk of environmental degradation, such as oil spills and tank accidents (as with the Exxon Valdez in 1989), but an even greater security threat might come from the lack of clear territorial boundaries.

A nation has sovereignty within its borders, which at sea is defined through the Exclusive Economic Zone (EEZ), which states 200 nautical miles (370 km). However, previous experiences indicate that these borders are easily breached and the Arctic is not the first case of territorial difficulties. The disputes between Russia and Norway over the Barents Sea and the Cod Wars between Iceland and the U.K. in the mid-1900s can be seen as two examples of conflict in this region resulting from the lack of territorial definition.

Against this background, Maas et al. points to the risk of "militarisation" of the disputes in the Arctic region, which they say is confirmed by the fact that Canada ordered eight military icebreaker patrol ships and a deep water port on their territory in 2006.[37] This is even more troublesome when bearing in mind an incident in 1995, when Canadian warships fired warning shots towards Spanish trawlers just outside the EEZ to highlight Canada's sovereignty. As more resources are found in an area considered 'no man's land', concerns are raised in some of the studies that the interests of strong nations may collide, especially since several non-Arctic countries, such as China, Japan and South Korea, are starting to articulate claims in the region.[38] Lee refers to this new situation, where a warmer temperature makes extraction of previously untouched resources economically viable, as a new 'cold war' where "conflicts are related to expansion of national interest, and actual periods of warfare may be short but intense".[39]

New trade routes

The ice melting around the North Pole could have several positive effects in terms of transport routes. As the Northwest Passage opens up, the navigation

[35] Schubert et al. 2008:133; Maas et al. 2010:24
[36] Gautier et al. 2009
[37] Maas et al. 2010:27
[38] Schubert et al. 2008; Maas et al 2010; NIC 2008
[39] Lee 2009:16

course from Germany to Japan could be reduced by 7,400 km, resulting in energy savings and reduction in emissions, as well as shorter sailing time and the avoidance of piracy in the Gulf of Aden. However, as argued by Lee, the opening of the Passage could lead to traditional security problems such as increased smuggling and the spread of exotic diseases, as well as problems concerning the human security of indigenous people due to the large transitions in demography and lifestyle.[40]

In order to benefit from the effects of climate change, a new institutional setting is required where territorial boundaries, environmental standards and rescue responses are clearly defined. For this reason, the EU has pronounced some concerns through a Joint Paper stating that the Law of the Sea may need to be revisited, since access to new trade routes and territorial claims could "challenge Europe's ability to effectively secure its trade and resource interest"[41]. The U.S. National Intelligence Council (NIC) is another official actor that has shown an interest in the strategic implications and geopolitical aspects of the Arctic region.[42] They argue that the region is of great importance not least due to the fact that the effects of climate change are likely to be seen during summertime in the next few years. The challenges are close at hand and will put pressure on territorial clarity and a settlement of legal status as regards who has the right to use the new trade routes.

For these two reasons, the access to previously hidden resources and the opening up of new trade routes, Maas et al. refers to the Arctic as the first "climate change induced constellation of insecurity"[43]. This is mainly due to the fact that climate change is not amplifying or triggering *existing* tension or environmental stress, but rather *creating* an entirely new situation which would not have occurred without climate change (e.g. population growth, ethnic grievance or scarcity of resources).

From a security point of view, following the argument in the studies analysed, climate change mainly poses a risk at the state level in the Arctic region. Even though there are risks of loss of biodiversity and impacts on the indigenous people leading to severe grievances, the dimension of human security is given little attention. Instead, it is the relationship between states and the clashes of actors' different interests in the region that is the main focus.

The severity of the security implications varies between the different studies. Shubert et al., even though presenting the region as a hotspot[44], are optimistic

[40] Lee 2009:58
[41] European Commission 2008:8
[42] NIC 2008
[43] Maas et al. 2010:26
[44] The reason for this is mainly due to the great capacity (in terms of military and economic power) of the states involved in the disputes.

about cooperation and multilateral agreements and therefore estimate that "the significance of the Arctic in security terms is low"[45]. This is based on the assumption that there are several frameworks to fall back on, such as the UN Convention of the Law of the Sea (UNCLOS), as well as the International Maritime Organization (IMO), which can mitigate the tensions.

A more pessimistic view of multilateral agreements results in somewhat different conclusions. Maas et al. emphasise the importance of the multiparty approach in peacefully resolving the competing interests of five of the major Arctic countries in the Ilulissat Conference in 2008. It is noteworthy, however, that Sweden, Iceland and Finland were not invited, despite being Arctic countries by definition. Maas et al. also state that the main problem is not a lack of agreements, but rather the implementation of international frameworks such as UNCLOS. For example, the U.S. has not even ratified this law yet, and many other states are now trying to get permission to extend the 200-mile zone.[46] In terms of international relations, the National Intelligence Council also emphasises the impacts of a changing landscape, where the opening of trade routes could result in new alliances such as between Russia and China and between smaller states with a great need for energy resources provided by the Arctic opening.[47]

3.2 South-East and Eastern Europe

3.2.1 The impacts of climate change on the region

This region has already experienced an increase in average temperature and estimates point to an overall increase of 1.6-2.6°C by the middle of this century.[48] This would not only lead to more frequent and severe weather events such as the heat waves that occurred in the region in 2001, but probably also a gradual decline in access to water.[49] Hence, water stress is one crucial impact of climate change, since the expected decrease in annual run-off in south-east

[45] Schubert et al. 2008:133
[46] Maas et al. 2010:27
[47] NIC 2008:53
[48] World Bank 2009
[49] Ibid.

Europe is between 20 and 30 per cent.[50] In this context, it is also important to note the seasonal variations in water availability, as the flow is likely to increase during winter but decrease in the summer, when it is needed the most. Furthermore, any increase in precipitation that might follow climate change will be offset by greater evaporation due to higher temperatures.[51]

The effects of climate change will be direct, as when extreme weather events such as heavy rainfall cause flooding and force people to evacuate certain areas, but there will also be an indirect effect in terms of gradual change and the negative impacts this could have on agricultural yields. The World Bank acknowledges the fact that some countries in the north of the region (e.g. Ukraine) would come out as winners from this point of view, as a warmer climate could be beneficial for agriculture.[52] However, due to the bad performance and low efficiency in the agricultural sector, the World Bank comes to the conclusion that the lack of functional markets and proper investments, especially in terms of road infrastructure, land clearance and marketing, may hamper these benefits.

In addition to the impacts of climate change, IPCC also emphasises adverse non-climate factors and trends as important for the predicted water stress, especially the eutrophication of lakes, poor water management and inefficient agriculture, which in known to be a highly water-intense industry.[53]

3.2.2 Vulnerabilities and security implications

The region is only explicitly recognised as a hotspot in one of the studies, where Maas et al. emphasise its close proximity to the EU and the fact that tensions could have spill-over effects on more stable countries within the EU, especially in terms of migration and energy security.[54] The authors therefore stress the tendency of governments in the region to view the problems of climate change as having a "military nature", thereby excluding important human security aspects such as worsening living conditions due to environmental risks or population movements.

The security implications identified in the study by Maas et al. are categorised into seven different themes:[55]

Economic deterioration: Agriculture and tourism are important sectors in terms of employment and income for the region and climate change will have impacts

[50] IPCC 2007a
[51] World Bank 2009
[52] Ibid.
[53] IPCC 2007a:545
[54] Maas et al. 2010:38
[55] Ibid.

on these sectors due to sea level rise, heat waves and changes in precipitation patterns. In Serbia, over 30 per cent of the workforce is employed in agriculture and in Albania the number is 50 per cent, i.e. half the population would be affected by a decline in agricultural yields.[56] Croatia is one of the countries trying to diversify its economy away from agriculture in favour of tourism. In 2007, the tourism sector generated around 20 per cent of GDP and employed roughly 330,000 people.[57]

Energy insecurity: Many of the countries in the region are struggling with hydrocarbon dependency and the change in precipitation will add additional challenges in the phasing out of these power sources. As a result, Maas et al. estimate that the use of nuclear power will rise significantly in many of the countries, not least in Ukraine, by 2030. Hence, the benefits from a warmer climate, which for example will prolong the season for tourism in Croatia, may be threatened by a decline in hydropower, which could lead to a decrease of as much as 50 per cent in the energy capacity of the country.

Food security: Substituting the domestic loss of agricultural yields will be difficult when the global food market is under similar stress and prices rise. For the region to benefit from the variation in crop yields, there is a need for a structural change in terms of infrastructure and production.

Population movements: Decreasing economic opportunities and the increased risk of extreme weather events such as flash floods are seen as providing incentives for migration, both within the region and into the European Union.

Ethno-political tensions: The movement of people could also trigger unresolved historical conflicts and political tensions.

Social tensions: The EU is already upgrading its border controls, especially towards the Middle East and North Africa. Additional pressure from Eastern Europe in an EU with internal economic problems could lead to hostility towards 'new arrivals'.

Authoritarian governance: The main characteristic of the region is that it consists of newly independent states with weak institutional and governmental capacity. Many of the countries are aiming at entry into the European Union and others are already on their way in (Croatia). However, climate-aggravated economic, food and energy crises could make authoritarian governance more attractive and considered more effective in handling the issues.

South-East Europe is also raised as a concern by the International Institute for Strategic Studies (IISS), which points to the fact that climate change does indeed present a threat to international security,

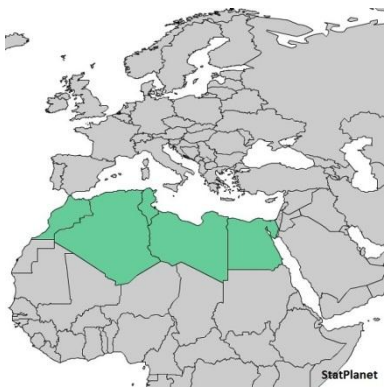
[56] Maas et al. 2008:35
[57] Maas et al. 2008:37

but this "cannot be solved with traditional tools of security – guns and bombs – instead, it should be addressed by 'whole of government' initiatives".[58]

The connection between climate change and conflict within this region is indirect, even though food insecurity as well as energy insecurity is at stake. A decrease in agricultural yields could lead to unemployment and loss of livelihoods, which in turn could provoke social tensions. The World Bank, however, regards the dire environmental situation and the poor state of infrastructure as the root of the vulnerability, rather than the changing climate over the next 10-20 years.[59]

3.3 Southern Mediterranean

3.3.1 The impacts of climate change on the region



Regardless of the SRES scenario adopted, this region will experience an increase in temperature and a mean annual decrease in precipitation, resulting in increased aridity.[60] Depending on the scenario, a direct effect of this would be a decline in the potential for hydropower in the region by 20 to 50 per cent by the year 2070.[61] This trend also converges with the fact that a warmer climate requires additional cooling and the energy needed for air conditioning is expected to increase by 28 per cent for the south-east Mediterranean region by 2030, and by as much as 50 per cent in Italy and Spain by 2080. Hence, the warmer climate will have direct impacts on energy consumption and water availability, as well as sectors dependent on these such as food production.

Regarding agriculture, IPCC claims that the sector accounts for 85 per cent of the annual total water resource in for example Egypt, and that low-efficiency irrigation systems play a major role in the extensive water stress. Furthermore, poor practices in the sector are leading to severe soil degradation, which poses additional threats to a sector that contributes more than 20 per cent of Egypt's total gross domestic product (GDP).[62]

[58] IISS 2011:10
[59] World Bank 2009:2
[60] IPCC 2007a:547
[61] IPCC 2007a:556
[62] IPCC 2007a:445

The exact impacts on water flows are complex, especially since the predictions on how precipitation patterns may change in the future are very uncertain. It is likely that the seasonal and regional variations will be large and that rainfall will decrease during summer when it is needed the most to replace the moisture evaporating from the soil.[63]

3.3.2 Vulnerabilities and security implications

From a societal point of view, many of the countries on the northern shore of the Mediterranean are rich in fossil fuels and have undergone an incredible transition in the last year (the Arab spring). How this develops is crucial considering the adaptive capacity of the new governments and is a good example of the 'wild cards' that must be dealt with carefully in the analysis. Southern Europe (the Balkans excluded) consists of consolidated democracies and EU members with better coping capacity towards climate insecurity, even though the biophysical risk is equally high as in North Africa.

Four studies recognise the Mediterranean sea as a vulnerable region not least due to the predicted water stress that could follow from climate change. [64] Maas et al. structure their analysis around some overarching categories, which mainly start in the socio-economic vulnerabilities rather than the biophysical exposure or effects of climate change, namely: *decreasing water and food security*, especially in those countries with high food import dependency and no fossil fuel reserves or lack of resources to compensate for the decline in domestic production; *militarisation of water disputes*, with the fact that the Nile river is shared by several countries and that the surface water is an external source being seen as having a negative impact on willingness to cooperate; *civil unrest*, as food crises and dissatisfaction with authoritarian governments could lead to riots and protests (as that study was conducted before the Arab spring, this aspect is now perhaps even more interesting); *displacement of large populations*, the region being seen both as a source and a destination of population movements, which in some cases would increase the pressure on already scarce resources such as shelter, food, water and energy; and *economic stagnation or decline*, as sources for external revenues such as tourism or export-orientated agriculture may be weakened by the effects of climate change. In addition to this, the costs of adaptation could divert resources away from other important investments in e.g. infrastructure. However, Maas et al continues, it is important to also consider the positive benefits that could result from climate change and the interest in reducing carbon emissions, as many countries now are exploiting the great potential for solar power in the region.[65]

[63] IPCC 2007a:446
[64] Schubert et al. 2008; Carius et al. 2008; Maas et al. 2010; IISS 2011
[65] Maas et al. 2010

Following the socio-economic consequences, the impacts of climate change on agriculture could have vast effects, which can be seen in the statistics provided by the World Bank. In Morocco, over 43 per cent of the population is directly employed in the agricultural sector and in Egypt the number is 31 per cent, with agriculture making up more than 15 per cent of total GDP in those countries.[66] When one-third of a country's population is dependent on continued agricultural yield to secure its livelihood, it is obvious that climate change poses certain risks in terms of human security.

In addition to the problems of domestic production, there are also global trends that could have an adverse effect on food security, as highlighted in a recent article by Feakin on the developments in food prices.[67] Algeria, Morocco and Egypt combined were responsible for almost one-third of the total global imports of wheat in 2008 to cover their needs. During this year, the price of several products, such as milk, rice and beans, rose by up to 50 per cent within a very short time, provoking disturbances and riots in several countries (which in the case of Egypt led to seven fatalities).[68] Even though the rise in prices may not be exclusively due to climate change and decrease in agricultural yield (a rise in demand is also of great importance), the problem of food insecurity is likely to increase as climate change continues and worsens.

Schubert et al. stress an important converging trend in the region, as population is estimated to have grown by 40 per cent until 2025, which means that the Mediterranean region would be home to more than 95 million people.[69] Along this track, the IISS study looks at the challenges of climate change on a more structural level, where they argue that an important aspect of food insecurity is the lack of functional global markets.[70] By starting their analysis with estimates by the UN that the world's population will be over 9 billion people by 2050, IISS comes to the conclusion that this development will require 70 per cent greater food production in the next 40 years. It also argued that climate change will create winners and losers and that the need for trade between the two will be crucial and will put pressure on the markets to function. A troublesome development argued in the study is protectionist attitudes, which have been noticed among several major exporters of rice (Thailand in 2008) and grain (Russia in 2010). This poses new types of threat to several import-dependent countries.

One area around the Mediterranean that is emphasised in all four studies that analyse it is the Nile Delta, as sea level rise is considered to have a negative effect on the sensitive area around the delta. Maas et al. point to a scenario where

[66] World Bank Data 2011
[67] Feakin 2011
[68] Feakin 2011:5
[69] Schubert et al. 2008:135
[70] IISS 2011:18

a sea level rise of 0.5 metres could result in salt water in the Nile up to 9 kilometres inland, destroying as much as 1,800 square kilometres of arable land, which is estimated to create a loss of over 38 billion US$.[71] Several coastal cities in the region (i.e. Alexandria, Casablanca and Tunis) have therefore already started the work of adaptation to sea level rise. In the case of Egypt, a country highly dependent on water from outside its own borders, the flow of the Nile is important and thus also relations with upstream countries (mostly Sudan and Ethiopia, who are also eager to make the most out of the water). The risk of a "militarization of disputes over water"[72] is therefore imminent, which is also emphasised in the study by Carius et al. They stress that almost 96 per cent of the available water in Egypt has external sources and that a water conflict triggered here will have a great risk of spill-over effects on neighbouring countries.[73]

Furthermore, estimates of the total population in the states bordering the Nile point to an increase from 280 million (in 2000) to over 860 million by 2050.[74] The delta is therefore identified as a particularly high-risk hotspot and even though the Nile Basin Initiative exists to coordinate the interests of the many actors, interstate tensions continue to grow and the agreement has proven to be an ineffective arena for conflict management.[75]

In sum, Carius et al. identify four key security risks resulting from climate change in the region[76]: *i*) by being a transit area for migrants to Europe, the tensions may increase along with climate refugees and displacements; *ii*) as food prices increase and scarcity of important products becomes more frequent, violent riots may occur (as has already happened in Algeria, Morocco and Egypt); *iii*) declining water levels and diminished run-off in rivers (such as the Nile) may lead to conflicts over a scarce resource;[77] and *iv*) the geostrategic importance of the region may attract external actors who want to secure their interests (and access to fossil fuels in e.g. Libya) as the stability in the region is compromised due to climate insecurity.

[71] Maas et al. 2010:31
[72] Maas et al. 2010:32
[73] Carius et al. 2008:38
[74] Stern 2006:113
[75] E.g. Schubert et al. 2008; Carius et al. 2008
[76] Carius et al. 2008
[77] Noteworthy here however that sea level rise is not taken into consideration as a security threat even though many coastal cities will be affected of it.

3.4 Sahel zone

3.4.1 The impacts of climate change on the region

There is no exact definition of the areas that should be included in the Sahel region, a strip of land running from the east to the west coast of Africa, dividing the Sahara desert to the north from the savannah to the south. At least ten countries[78] have borders towards the region, which is characterised by frequent drought, retreating vegetation, soil erosion and desertification.

Due to the complexity of climate change, the projections for precipitation and temperature provided by IPCC are uncertain and seasonal variability is expected to be large, with some models pointing to significant drying of the region and others to progressive wetting, with an expansion of vegetation into the Sahara.[79] Alongside interannual variability, it is even possible that climate change could lead to an increase in both extremely dry and wet years.[80]

A major sector that will be affected by climate change according to IPCC is agriculture, and the Sahel region will be negatively affected as semi-arid (marginal) areas and other rain-fed land decrease significantly by the 2080s.[81]

3.4.2 Vulnerabilities and security implications

Several reports highlight Africa in general, and above all the Sahel zone, as a particularly vulnerable region.[82]. The reason for this is to some extent the climate context, but much of the analysis is 'vulnerability-driven', where climate change is seen as one of many factors in a region with multiple stresses, such as destructive impacts of war, extreme poverty and weak institutional capacity.

Carius et al. use two indices as a starting point when identifying the regions for their analysis; The Failed State Index and the Environmental Vulnerability Index.

[78] Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Gambia, Guinea-Bissau, Chad and Sudan
[79] IPCC 2007a:444
[80] Ibid.
[81] IPCC: 448. The SRES-scenarios used for the analysis was A1 and B1
[82] Schubert et al. 2008; Carius et al. 2008; U.K. MoD 2008

The major threat posed by climate change is seen in the struggle over scarce resources that may lead to further tension in already weak states, not least through desertification, which may accelerate rural migration.[83] Hence, the focus is placed on the adverse effects of climate change on agriculture and the expected loss of livelihood that may follow. A second threat acknowledged by the authors is the sea level rise and the effects this could have on urban coastal regions. Several countries in the region are vulnerable to additional stress, as many of them are characterised by "fragility and governance deficiencies", where the problems of climate change may give rise to the "emergence of a transcontinental belt consisting of mutually reinforcing fragile states".[84]

Schubert et al. take a similar position, stressing the socio-economic vulnerability among the states by pointing to the low ranking on the Human Development Index established by United Nations Development Programme (UNDP).[85] The effects of climate change on agriculture are therefore crucial in terms of human security within the region as the risk of food insecurity and loss of livelihood is imminent. This is because most of the farmers living in the region are dependent on agriculture (mostly millet), exports of cotton and cattle rearing, which are all very sensitive to changes in precipitation and temperature. Furthermore, conflicts have been reported between nomadic animal herders and more economically viable arable farmers, who are fighting for an increased share of an area of land which is constantly under great pressure, due to population growth but also because of desertification.[86]

Many of the countries in the region are also lacking sea ports and well-functioning infrastructure, which increases the vulnerabilities connected with reliance on imported food. Schubert et al. therefore conclude that the region could experience climate-induced destabilisation and even potential for violent conflict over scarce natural resources. However, they consider this to remain low-intensity and the risk of conflict on a large scale unlikely in the region, although this is difficult to predict due to the complexity of actors involved and the history of violence that characterises the region, as well as the possibility of massive displacement of refugees from conflict-torn neighbouring regions.[87]

There are also several organisations active in Sahel which could have a mitigating effect on the tensions. Most important perhaps is the Comité Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS), which consists of all of the abovementioned Sahel countries in an attempt to develop the regional competence regarding food security, natural resource management and

[83] Carius et al 2008:40
[84] Carius et al 2008:41
[85] Schubert et al. 2008:137
[86] Schubert et al. 2008:138
[87] Ibid.

desertification. It also serves as a promoter of solidarity between the member states and the international arena.[88]

In sum, the Sahel zone is a region already experiencing aridity and the vulnerabilities identified in the studies are mostly focused on socio-economic factors and threats to human security and livelihood.

3.5 Southern Africa

3.5.1 The impacts of climate change on the region

This region covers a large geographical area that will experience a wide variety of effects of climate change. In the equatorial parts of the region, IPCC estimates point to a slight increase in rainfall, whereas most other parts will see a decrease both in the number of rain days and average intensity of rainfall.[89] Until very recently, the use of water in agriculture in most countries of Southern Africa has been balanced or nearly sustainable. However, an increase in temperature even below the anticipated 2°C level will have devastating effects on the region as several new areas will become arid (an increase of as much as 90 million new hectares of arid areas by 2080 is predicted), which will have negative effects on maize production and humans, as well as on important biodiversity.[90] However, this major impact of climate change is dependent on future adaptive capacity within the countries, which could reduce the negative effects and reap benefit from the potential positive effects, such as a longer growing season in certain regions (e.g. Mozambique) and livestock rearing by small farmers who are able to acquire heat-tolerant species.

3.5.2 Vulnerabilities and security implications

The region is identified as a hotspot of climate change in the study by Schubert et al., not least due to the expected increase in water stress. The reason why the region is given a marginal role in the other studies is not explicitly stated, but isolating the impacts of climate change on security is very complex which could

[88] Schubert et al. 2008:138
[89] IPCC 2007a:444
[90] IPCC 2007a:448

be why Schubert et al. once again acknowledge the low ranking on the Human Development Index of the countries in the region.[91]

Hence, much attention is given to the aspects of human security and climate change is considered to "compound existing problems by having a seriously detrimental effect on regional food production, water supplies and accelerating soil degradation".[92] This is important in terms of security, since many of the states in the region could be described as relatively stable in comparison to many other African countries. However, for many disadvantaged groups the state often plays an irrelevant role, and in some cases even represents an additional problem rather than a guarantor of security and well-being.

In their more general chapter on Africa, Carius et al. also acknowledge the region briefly as a whole by stressing the problems of sea level rise, as it contains several vulnerable cities with more than one million inhabitants in coastal areas (e.g. Dar es Salaam in Tanzania, Cape Town in South Africa and Freetown in Sierra Leone).[93]

In sum, the risk of a large-scale conflict in the region due to climate change is unlikely but tensions in society along ethnic and social lines are already high and it is therefore "probable that there will be an increase in local and potentially violent resource conflicts".[94]

This will all be dependent on the cooperative capacity among states, as several institutionalised intergovernmental agreements have been established on a wide range of issues.

[91] Schubert et al 2008:140
[92] Ibid.
[93] Carius et al. 2008:41
[94] Schubert et al. 2008:141

3.6 South-West Asia

3.6.1 The impacts of climate change on the region

Even though this region comprises heterogeneous countries with varying adaptive capacity, the challenges they face from climate change are similar. Decreasing precipitation and increasing temperature are predicted, which will lead to even greater water shortages in an already arid region.[95] This factor will coincide with a rise in demand for and consumption of water as the need for irrigation and coolant for industrial facilities increases. The agriculture sector is therefore expected to experience negative effects of climate change, with a possible decrease in cereal yields of as much as 30 per cent by 2050.[96]

3.6.2 Vulnerabilities and security implications

The region is poorly covered in the studies included here and is only briefly used as an example when discussing specific topics (e.g. food or water insecurity). In the study by Carius et al., the region is considered vulnerable to climate change, since it could have an effect on two socio-economic factors by causing e*conomic decline and stagnation in resource-rich countries* and by *arresting instability in conflict areas*.[97] Considering the first factor, climate change is seen as having various impacts on financial resources. First, coping with the adverse effects will bind large amounts of financial resources, which could strain even the budgets of oil exporting countries; and second, if climate change converges with a decrease in fossil fuel revenues this would lead to an economic downturn in many of the countries. Since several countries have built their stability on constant provision of public goods, subsidies and high wages within the public sector, a decline in government spending could have adverse effects on the loyalty of the citizens. This would mainly affect security on the state level, but if the regional cooperation comes under stress countries could destabilise further and pose security risks to their neighbours. Creating a more diverse economy outside the

[95] IPCC 2007a:477
[96] IPCC 2007a:481
[97] Carius et al. 2009:9

fossil fuel sector should therefore be a priority for many of the countries around the Persian Gulf.[98]

The importance of a more diverse economy is also acknowledged in another study on the impact of climate change on the region where the author states that, for richer countries such as Saudi Arabia and the United Arab Emirates, the reports of dwindling water reserves have led to strategic overseas investments in agriculture through partnerships with countries in Africa and South-East Asia.[99] Other countries, unable to rely on oil revenues and costly adaptation strategies, have shown signs of competing in a 'race to the bottom'. One such country is Yemen, which is totally dependent on the production and export of the mild narcotic qat. Instead of putting in place efficient regulation and water management, groups in the society are focusing on short-term profits, resulting in rapid soil erosion and water depletion as the production of qat represents more than two-thirds of annual water consumption in the country.[100]

The second socio-economic factor, i.e. arresting instability in conflict areas, mainly concerns the problem of water shortages and the inability of weak governments to deal with the competition between the usage of this scarce resource, as water scarcity is closely connected with the problems of energy security. Predictions point to a decline in river run-off, which would negatively affect the production of electricity through hydropower plants. At the same time, population growth will create a greater demand for electricity, both to run water pumps but also for cooling devices as the region heats up.[101]

The greater need for energy could give additional momentum to the use of nuclear power, a resource that is already an option for many countries in South-West Asia. The Iranian nuclear programme has been identified as a security threat by the Gulf Cooperation Council (GCC), and an arms race in the region is a possible scenario if the international community fails to prevent Iran from developing a military nuclear programme.[102]

To recapitulate, the security risks within the region are the result of a gradual climate change having both direct effects, such as water scarcity, as well as indirect effects, such as a decline in oil revenues. One important aspect that needs to be considered is the geographical position of the region and the proximity to even more conflict-prone and vulnerable countries in East and North Africa. Carius et al. therefore point to the risk of large-scale migration into oil-rich states, where social tensions have the potential for violent conflict.[103]

[98] Carius et al. 2009
[99] Kumetat 2009
[100] Kumetat 2009
[101] Carius et al. 2009 :11
[102] Stracke 2008
[103] Carius et al. 2009

3.7 Central Asia

3.7.1 The impacts of climate change on the region

The region has experienced a rather high increase in air temperature. Since the beginning of the 1970s, the temperature has risen by 0.3 to 0.4°C per decade, which is more than twice the global mean.[104] Future climate change is also expected to lead to an increase in mean air temperature and, in addition to this, the annual quantity of precipitation is anticipated to decline slightly and the seasonal differences between winter and summer are likely to be exacerbated. These trends could have a negative effect on food production and lead to a loss of as much as 30 per cent of crop yields in the region.[105]

The rise in temperature will also intensify the melting process in mountainous regions such as the Tienshan glacier in Kyrgyzstan.[106] Since melt water from these areas makes up a significant part of the rivers, which in turn are used for irrigation and as a source of fresh water, the long-term effects of the decline in glaciers could be adverse.

3.7.2 Vulnerabilities and security implications

Three of the studies analysed here recognise the region as a hotspot of climate change, especially when considering future scarcity of water.[107] This could have an impact on the agriculture sector, which Schubert et al. argue is crucial for maintaining livelihood and human security, since it is the basis of the economy in many countries in the region, often accounting for up to 40 per cent of GDP.[108] Already, the proportion of agricultural land requiring irrigation ranges between 75-100 per cent in the region and if the predictions of decreased precipitation become reality, water stress could have important negative implication on this sector.

[104] Schubert et al. 2008:141
[105] IPCC 2007a:479
[106] IPCC 2007a:477
[107] Schubert et al. 2008, Lee, 2009; Maas et al. 2010
[108] Schubert et al. 2008:142.

Schubert et al. also acknowledge that water scarcity could have an impact on another important economic sector, namely hydroelectricity. Tensions between states that are competing over this resource have been identified, as rivers flow through different states and clashes of interests can be seen between those who need water for electricity (e.g. Kyrgyzstan and Tajikistan) and those who want it for irrigation in the summer (e.g. Uzbekistan, Kazakhstan and Turkmenistan).[109] In relation to this, Maas et al. point out that from a short-term perspective, many of the countries are likely to see positive effects of climate change as the water flow will increase, thus improving the situation for farmers and the energy sector. However, as precipitation patterns change further and the water reserves run short it is likely that the countries will see a decline in exports of cotton and hydroelectricity, as well as more frequent landslides and loss of habitable and arable land.[110]

In the analysis by Lee, institutional capacity of within the region is identified as a major concern. In terms of climate change, most of the challenges for the region are the result of a gradual shift. This would imply that the ability to adapt and make long-term plans is better these countries than if they were struck by sudden, extreme events. However, due to the post-Soviet legacy, governments in the region are weak and are lacking the important legitimacy needed for future planning and the strengthening of institutions. In addition to this, there are ethnic tensions and social impoverishment, which could increase the security risks in the region.[111]

Two areas that receive some additional attention in the regional analyses by Schubert et al. and by Maas et al. are the Aral Sea and the Caspian Sea. An article by the World Bank also highlights the Aral Sea which was once the fourth largest lake in the world, located on the borders of Kazakhstan and Uzbekistan. As the region started to be more densely populated, the surface area of the lake shrank by almost 70 per cent between 1960 and 2004 as water was diverted for irrigation.[112] Since the problem was acknowledged, attempts have been made to save what is left of the lake, as well as costly efforts to actually increase the flow of water to restore its original state. Whether this will succeed is debatable, but keeping the challenges of climate change in mind has led at least two of the studies included in this report to consider the Aral Sea as a 'particular hotspot', as the region will experience desertification, soil erosion and a decrease in water availability due to evaporation.[113]

In the case of the Caspian Sea, however, the risks are considered to be greater. The sea has maritime borders to five more or less powerful countries;

[109] Schubert et al. 2008:142
[110] Maas et al. 2010:40
[111] Lee 2009
[112] World Bank 2008.
[113] Maas et al. 2010; Schubert et al. 2008

Azerbaijan, Turkmenistan, Kazakhstan, Russia and Iran, and it should be noted that there is no agreement or settlement in place for mitigating the tensions in the territory. The main problem with the Caspian Sea is its legal status, or rather lack thereof, which should confirm whether it is considered a lake or a sea. This has great implications on the user rights to the vast resources that are hidden beneath the surface, such as fish, oil and gas.[114] Due to its inland position, the level of the Caspian Sea is predicted to drop, possibly by up to 9 metres by the end of the century. This will require heavy investments in coastal infrastructure, port cities and future fishing techniques, but in order for this to be feasible countries around the sea need to settle their disputes on user rights and who has access to what part of the area.[115]

A final important aspect in the region is based on geopolitics. In Central Asia, as in the rest of the world, global developments and converging trends could have an impact on the unstable internal situation. The geostrategic importance of the region has increased due to the on-going conflict in Afghanistan and the risk of spill-over effects, as the region could become a hub for the international drug trade. The fact that the region is rich in important resources such as fossil fuels has also drawn attention from several actors with potentially conflicting interests, such as USA, Russia and China.[116]

3.8 East Asia

3.8.1 The impacts of climate change on the region

Already today, crop yield in many countries of East Asia has declined due to rising temperatures and more frequent extreme weather events. Hence, there is a need for long-term adaptations to respond to the gradual shift in precipitation patterns and temperature, as well as a more resilient society that can absorb the effects of sudden extreme weather events such as storms and flooding.

The gradual change will have adverse effects in several ways, not least on the climate-

[114] Eurasianet 2009
[115] Maas et al. 2010:42
[116] Schubert et al. 2008:142.

sensitive agricultural sector, which could experience as much as a 30 per cent decrease in crop yields by the year 2050 due to higher temperatures and water stress.[117]

Regional differences will be large and there could even be some positive effects of climate change due to the so-called CO_2 fertilisation effect. However, to benefit from this, sustainable land use is required in order to avoid soil degradation which is likely to occur as a result of over-use.

Another risk accompanying warmer oceans is that of an increase in endemic morbidity due to diarrhoeal diseases. As water temperature increases so does the toxicity of cholera and other vector-borne and water-borne diseases. Large investments are therefore needed in order to cope with the sanitation needs and lack of clean water.[118]

The gradual increase in temperature will also have an impact on the great glaciers in the Himalayas and the Tibetan highlands, which are the main water source for millions of people. Although run-off will increase during a short time as the glacier melts and the region experiences heavier rainfall, there is a clear risk of water stress in a long-term perspective.

An effect that is difficult to predict, but which could have a major impact on the access to water, is changes in the monsoon, a weather phenomenon which is crucial for agriculture in many of the countries but would have devastating effects such as flooding if amplified in the future. This is especially true if, at the same time, water run-off increases as glaciers melt in the Himalayas.[119]

3.8.2 Vulnerabilities and security implications

The study by Carius et al. and that by Schubert et al. both identify two problems following climate change: sea level rise and changes in the monsoon. Carius et al. conclude that sea level rise could lead to territorial loss and threaten the habitation of nearly 40 per cent of the population in the region, having a particularly adverse impact in Bangladesh, where more than 35 million people are estimated to live near coasts.[120] Hence, there is a great need for long-term planning in order to adapt to effects of sea level rise such as territorial loss or salinisation. However, as Schubert et al. recognise the trends so far are moving in the opposite direction, since many countries are experiencing rapid urbanisation into low-lying coastal cities (e.g. Dhaka, Calcutta, Karachi and Mumbai).[121]

[117] IPCC 2007a:482
[118] IPCC 2007a:471
[119] IPCC 2007a:479
[120] Carius et al. 2008:42
[121] Schubert et al. 2008:144

The other effect of climate change identified in the studies is the change in monsoon. Carius et al. note the dependence on the monsoon for the regional economy and conclude that a change in the patterns of precipitation will have "far-reaching consequences for the entire economy".[122] This is also emphasised by Schubert et al., who argue that a greater seasonal variability in precipitation in terms of droughts and heavy rain will lead to a significant loss of harvest.

However, the most important security implications in the analysis by Schubert et al. are the internal and domestic disputes over resources. Since all of the countries in the region are more or less dependent on agriculture, there is a clear risk that climate change will put additional stress on already tense relations as agriculture is highly sensitive to climate change.[123] The security implications differ greatly between the different countries in the region, but there are some direct tensions between states when it comes to planned and completed dam buildings. A typical example of this is the diverted flow of the Ganges caused by India's large-scale project with the Farakka dam, which had a devastating impact, both economically and ecologically, on Bangladesh. Projects such as this, in combination with other unresolved internal disputes, have led to several cases of migration within Bangladesh and as cross-border migration into India, where violence has occasionally been the response.[124]

The socio-economic factor is important when looking at security risks. Even though the region has experienced economic growth in recent years, there are still around 410 million people living in poverty.[125] The escalation of conflict could be the result of a better awareness of the increasing social inequality and inadequate access to social services among the rural population. If these grievances are concentrated around existing ethnic and religious tensions, the voices could be violently expressed through conflict between different groups in the society.

In China, a country only covered by Schubert et al., the situation is slightly different. The country's economy is considered a "major economic success story", with an annual GDP growth of almost 9 per cent and a decline in people living in extreme poverty (less than 1 US$ a day) from 60 per cent to 10 per cent between 1981 and 2003.[126] However, the income disparities within the different regions of China are large, which has led to massive urbanisation and internal migration from rural areas to major cities particularly located in the coastal areas. The massive economic growth has also been costly, especially in terms of environmental degradation. Human health is also at risk, not least in the many 'cancer villages' that have popped up as a result of the production industry, and

[122] Carius et al. 2008:43
[123] Schubert et al. 2008:146
[124] Schubert et al. 2008:146
[125] Schubert et al. 2008:145
[126] Schubert et al. 2008:147

protests have started to grow about the conditions in factories and within production. The agricultural sector, which is still the livelihood for 45 per cent of China's population, is also under greater stress due to soil degradation and deforestation, which has resulted in minor ethnic conflicts in rural areas.[127]

China has therefore several challenges to manage and proper adaptation in the short and long term is needed in order to avoid tensions. This could have implications both in terms of international relations, with tougher negotiations on CO_2 emissions in a carbon-constrained world, as well as domestic questioning of the Chinese leadership, which is built on constant growth and a promise to modernise the country. Much will therefore, according to Schubert et al. depend on the 'willingness to suffer' among the Chinese people and on how long the government has a mandate to solve the many challenges of the future.[128]

In sum, East Asia will experience a wide range of impacts of climate change. However, the uncertainty regarding actual climate change in the future, along with rapid societal developments in the region, affects the accuracy of the regional analysis. Regional variability also implies that the challenges posed by climate change will differ and must be dealt with in different ways.

3.9 South America

3.9.1 The impacts of climate change on the region

The regional variability in predicted climate change is large in South America, where increases in heavy rainfall have been observed in Paraguay, Uruguay and some parts of Brazil and Bolivia, whereas a declining trend in precipitation has been observed in for example southern Chile and Peru. The projected mean warming of the region ranges from 1 to 4^{o}C for the B2 scenario and 2 to 6^{o}C for the A2 scenario, which could have an adverse effect on the important glaciers of the Andes.[129]

[127] Schubert et al. 2008:147
[128] Schubert et al. 2008:149
[129] IPCC 2007a:583

Many of the rivers in the region are sustained by glacier melt and as these glaciers retreat due to global warming, river flows will increase in the short term but gradually decrease over the next few decades. This fact, in combination with increasing precipitation variability, is likely to affect the water supply to the more than 50 million people dependent on water run-off in the area today.[130]

A further aspect of water shortages is the disruption of transport routes. As the water level sinks in rivers, today's transport channels for goods, people and medical care, such as boat routes, will become impassable. This problem might solve itself as the potential sea level rise will have an impact on the Amazon delta, but these aspects have not been sufficiently studied and are not dealt with in detail in the studies examined here.

In terms of extreme weather events, the region is likely to suffer both in terms of intensity and frequency. During recent decades, several unusual events have been reported by IPCC, such as the heavy rains in Venezuela, the Amazon drought in Brazil, the record hurricane season in the Caribbean Basin and the first hurricane (Catarina) ever observed in the South Atlantic.[131]

3.9.2 Vulnerabilities and security implications

Most of the attention given to the region is directed towards the governmental capacity and less towards the actual effects of climate change. The melting of glaciers is a problem, but in addition to this there are several non-climate issues which exacerbate the challenges, especially the soil degradation coming from non-sustainable land use. A response to this problem has been the deforestation of the Amazon region in order to satisfy the demand for beef, soy bean and bioethanol from sugar cane.

Schubert et al. provide estimations which point to the alarming fact that 30 per cent of the Amazonian forest will disappear if the present trend in deforestation continues.[132] A country of special importance in order to manage this problem is Brazil, one of the leading economies in the world but with great income disparities and social injustice in rural areas. In a quest to tackle poverty, but at the same time protect the Amazon from over-exploitation, several conflicts of goals have become evident and created tension within the country. On the one hand the government's environmental plans for protected areas are clashing with economic goals regarding exports of agricultural commodities such as meat and soy bean, as well as energy plans for building dams and securing a sufficient

[130] Stern 2006:57
[131] IPCC 2007a:585
[132] Schubert et al. 2008:154

supply of electricity for industries. On the other hand there are tensions around land use between small farmers and people involved in cattle-rearing.[133]

In other parts of the region, such as Ecuador and Peru, soil degradation is arising from the problem of salinisation. In a short-term perspective, this problem could be counteracted by so-called targeted over-irrigation from the abundant water resources following glacier melting. Combined with even higher temperatures, however, the disappearance of the glaciers and the shortage of water will most likely increase anthropogenic desertification due to overgrazing and deforestation.[134]

Climate change may also lead to an increase in the frequency and intensity of droughts. As highlighted by Carius et al., unabated global warming will therefore have negative impacts on countries heavily dependent on hydropower such as Brazil, where more than 90 per cent of the electricity supply comes from hydroelectric plants. The vulnerability of this dependency can be seen in the collapse of the infrastructure that occurred in Brazil due to the major drought in 2001, which in combination with an increased demand for energy led to a drop of 1.5 per cent in GDP that year.[135]

In terms of converging developments that could increase the socio-economic vulnerabilities in the region, both uncontrolled urbanisation and short-term rent seeking must be mentioned. The large-scale internal migration of people to cities in the hope of a better future continues, making South America the most urbanised region in the developing world with more 75 per cent of its population living in city areas. In turn, this is leading to more or less traditional risks such as the expansion of slums and a weak rule of law where organised gangs are held back by private security services, which creates a civil war situation in many cities.[136] This not only affects human security for the people living in the area, but could also have a spill-over effect on nearby regions as people choose to migrate to other areas. Climate change could affect this trend in both direct and indirect ways. It is likely that the speed and scale of urbanisation will increase as geographical areas become inhabitable, but this migration will often be uncontrolled and result in ‘cities within cities’ often created in vulnerable areas where the risk of mudslides and floods is high.[137]

Another important factor that plays a part in the inability to cope with the impacts of climate change is the short-termism or myopia that defines many of the governments in the region. Instead of focusing on strategic and sustainable management of adaptation, governments are devoting their efforts to rapidly

[133] Schubert et al. 2008:154
[134] Schubert et al. 2008:152
[135] Carius et al. 2008:29
[136] Carius et al. 2008:56
[137] IPCC 2007a:587

increasing agricultural exports and resource extraction. This in turn leads to macroeconomic stability and secures the control of powerful interest groups. However, the price could be high in the future when agriculture is negatively affected by a less favourable climate and when the extraction of natural resources such as oil and gas in the Andean region diminishes.[138]

Schubert et al. conclude that the conflicts currently occurring in the region do not have international or even national implications, but are rather settled on a regional level. However, as major infrastructure projects continue, such as the diversion of rivers in the Lambayeque region of northern Peru, there is a risk of interstate tensions between those parts of the region rich in water and those which are poor, such as between the highlands of Peru and the lowlands of Ecuador.[139]

There are several factors at play when looking at why a region is prone to climate change-related conflict. Deforestation, soil degradation, rapid urbanisation and water stress are just some examples of challenges that can be found in a wide range of regions recognised in the chapters above. Before turning to the methodological considerations in the next chapter, this section ends with a brief summary of the regional analysis.

3.10 Summary of regional analysis of hotspots

This chapter has presented basic data on the expected effects of climate change and the implications it may have on vulnerabilities and security consequences according to nine studies on this matter. The analysis has been orientated around nine regions in the world which are summarised below.

The Arctic
Climate change has a direct effect on the region in terms of a decline in glaciers and a reduction of the Arctic sea ice which could lead to a loss of livelihood for the approximately four millions habitants as well as threatening important economic activities by causing severe damage on strategic harbours. If managed well however, there are some potential benefits following climate change in terms of liberation of natural resources (e.g. fossil fuels and mineral) and the opening of new trade routes through the Northwest Passage.

Security implications for the region are primarily found in the lack of clear territorial boundaries and user rights for the extraction of previously hidden resources and the risk of a militarization of the disputes due to the conflicting interests between powerful states.

[138] Schubert et al. 2008:156
[139] Schubert et al. 2008:153

South-East and Eastern Europe
Climate change in the region is likely to provoke water stress in the region due to the expected decrease in annual water run-off. Seasonal variability will be large causing sudden impact in terms of flooding due to heavy rainfall, as well as more gradual and indirect impacts such the decline in agricultural yields due to a warmer climate. Some countries in the region, as for instance Ukraine, could in fact experience an increase in agriculture productivity but in order to benefit from these changes several obstacles need to be tackled such as the lack of functional markets and proper investments in road infrastructure.

Security implications for the region are primarily found in the possible economic deterioration as two important sectors – tourism and agriculture – are highly climate-sensitive. This could exacerbate existing ethno-political tension as some parts of the population are forced to migrate as a result of e.g. food insecurity. The closeness to the European Union is also emphasised as an important factor for recognising the region as a hotspot.

Southern Mediterranean
Climate change in the region will lead to an increase in aridity as precipitation decreases and mean temperature is increasing. This will have an impact on several important sectors such as agriculture and hydropower production, where the latter coincides with an increased demand in energy-intense activities such as cooling due to a warmer climate.

Security implications for the region are mainly found in the decreasing of water and food, the militarisation of water disputes, displacement of large populations and economic stagnation. As the Arab Spring has shown however, the region consists of several 'wild cards' as to how the adaptive capacity to these challenges will develop in the future. The dependencies on food imports make several of the countries in the region vulnerable to price hikes which in turn could lead to civil unrest and riots. An area recognised as particularly prone to security risks is the Nile Delta due to the number of bordering states and the population density along the river.

Sahel zone
Climate change in the region will lead to even greater aridity even though seasonal variability could increase. The region is already characterised by drought, retreating vegetation, soil erosion and desertification which all are phenomenon likely to be exacerbated by climate change.

Security implications for the region are found in the prevailing socio-economic vulnerability where climate change will merely be an additional factor and a multiplier. From a human security point of view, many of the farmers in the region are dependent on exports from cotton and cattle rearing which are both very sensitive to changes in precipitation and temperature. Conflicts have so far been reported between nomadic animal herders and more economically viable

farmers with conflicting interests over land-use. The conflicts are likely to be low-intense and caused by migration to already populated areas with shortage of food and water.

Southern Africa

Climate change will vary in the different areas where the equatorial parts may experience an increase in rainfall but the major part of the region will see a decrease both in the number of rain days as well as in the average intensity of rainfall. This will in turn lead to an increase in aridity with negative effects on for example maize production. If the adaptive capacity increases in the future a potential benefit could be the prolonged growing season in countries such as Mozambique.

Security implications for the region are mainly the result of severe water stress affecting human security and wellbeing. There are also some risks following sea level rise as the region contains several vulnerable cities in coastal areas.

South-West Asia

Climate change will lead to a decrease in precipitation and increase in temperature causing even greater water shortages in an already arid region. In turn this will coincide with an increase in demand for, and consumption of, water due to the needs for irrigation and coolant in industrial facilities. The agriculture sector is also likely to be negatively affected with a significant decrease in cereal yields.

Security implications for the region, following climate change, are found in water and food shortages on the one hand, and in more socio-economic vulnerabilities on the other hand, mainly the economic decline and stagnation in resource-rich countries. Coping with the adverse effects of climate change will bind financial resources which in turn may lead to cuts in the public sector and civil unrest. There is also a risk of large-scale migration from the fragile states in the North Africa into oil-rich countries where social tensions may have the potential for violent conflict.

Central Asia

Climate change has already been observed in the region with a temperature rise of more than twice the global mean during the last four decades. A warmer temperature will intensify the melting process of important glaciers in the mountainous areas which, along with greater seasonal variability in precipitation, could lead to a severe water stress in the region affecting both hydropower plants as well as the agriculture sector.

Security implications for the region could come from both socio-economic vulnerabilities where a large proportion of the population is employed in the climate-sensitive agriculture, as well as tensions between actors with conflicting interests regarding water use such as electricity production and irrigation needs. A post-Soviet legacy of many countries also hampers the development of an

adaptive capacity due to a lack of institutional legitimacy and trust. Two areas are considered as particular hotspots, the Aral Sea and the Caspian Sea which are rich in natural resources such as fish and fossil fuels. Due to poorly defined user rights however, tensions between several powerful actors have already been observed, as between Russia and Iran over the Caspian Sea. The geostrategic importance of the region has also increased due to the on-going conflict in Afghanistan.

East Asia

Climate change poses both direct threats on the region in terms of extreme weather events, but it has also an indirect effect in terms of a gradual increase in temperature leading to a decline in crop yield. The warmer temperature also has an impact on the Himalayan glaciers providing freshwater to millions of people in the region. The annual run-off from the glaciers will increase during a shorter timeframe but in a longer perspective the region will likely experience water stress even if the frequency and intensity of heavy rainfall increase.

Security implications for the region are found in the expected sea level rise threatening the habitation of millions, and the changes in monsoon crucial for the important agriculture sector. A greater seasonal variability in precipitation, with droughts and heavy rainfall respectively is a major challenge for the long-term planning and adaptation for all of the countries in the region. An already observed tension is connected to the building and planning of dams which is diverting water and having devastating impacts both economically and ecologically for many people in the area. China is primarily recognised through the problems of environmental degradation and the threats to human security due to local pollution from industries.

South America

Climate change in the region will vary greatly with more frequent heavy rainfall in some and a declining trend in precipitation in other parts. A major impact of climate change will be the melting of glaciers in the Andes, threatening the long-term provision of freshwater to millions of people. Extreme weather events are also likely to be more frequent, as well as more intense.

Security implications for the region are found in the governmental incapacity to manage and cope with the effects of climate change in an effective manner, especially in terms of non-climate factors such as soil degradation and the deforestation of the Amazonas. Climate change is also likely to cause more frequent droughts and water stress with several negative impacts on countries dependent on hydropower such as Brazil. A converging trend which exacerbates the challenges posed by climate change is the rapid urbanisation into several cities in the region. Not only will climate change increase the speed or urbanisation as large areas become inhabitable in the future, but it also threatens life in the ‘cities within the cities’ which often emerge uncontrolled and where risks for mudslides and flooding is much higher.

4 Concluding discussion

This report not only examines how nine studies frame the connection between climate change and security but also which regions these studies recognise as particularly vulnerable to climate change. This analysis was the main focus in chapter 3. An additional aim in the prevailing report has been to look at the methodology used for identifying vulnerabilities and hotspots. Four aspects have guided this analysis; biophysical exposure, socio-economic vulnerabilities, environmental degradation and a history of violence. In the following section these aspects are discussed in order to illustrate the methodology predominantly used in the nine studies. This report concludes thereafter with a short summary of the findings and suggestions for further analysis.

4.1 Methodological considerations

The linkages between climate change and security risks are sometimes direct, as with territorial loss due to sea level rise or flooding caused by more frequent and intense rainfall. More often, however, climate change poses indirect threats to people's livelihood and everyday life, for example through a gradual decline in agricultural yields or access to freshwater. As will be evident, a study's point of departure are therefore of importance regarding what security implications that are recognised in a specific region. In relation to this, an important distinction can be made between an impact-driven analysis and a vulnerability-driven.

4.1.1 An impact or vulnerability driven analysis

An impact-driven analysis uses the effects of climate change as a starting point. Thus, regions with a high degree of biophysical exposure and where future impacts of climate change are predicted to be large are recognised as prone to security implications. Much of the analysis on the Arctic region is impact-driven in the sense that the effects of climate change will create new challenges and the region would not have been given attention without this. All of the regions identified as hotspots in the work by Schubert et al. emerge from an impact-driven approach, where particularly adverse effects of climate change are mapped and the impacts on societies are analysed accordingly.

Using freshwater as an example can be vital in order to portray the logic of the regional analysis and the attention that is given to the aspects of biophysical exposure. Freshwater is crucial for food security and poverty reduction, as approximately 70 per cent of the world's water resources are used for farming.[140] When climate change provokes water stress, either through distorted

[140] Schubert et al. 2008:160

precipitation or melting glaciers, the impacts on agriculture and the rural population could be severe. At the same time, water could be an important resource in terms of e.g. hydropower and competition over this scarce resource could lead to tensions and even conflicts within societies, but also to cooperation.[141] As such the impacts alone are not sufficient in the analysis. How societies respond is crucial when analysing the consequences following climate change.

The most common approach when analysing security implications and vulnerabilities connected with climate change is to look at existing weaknesses, not least in terms of *socio-economic vulnerabilities* since those are pivotal for what consequences that might follow. A subsequent step is then to 'add' the effects of climate change into this complex web of interplaying factors such as agricultural dependencies, ethnic grievances and political conflicts.[142] Hence, the analysis is vulnerability-driven in the sense that climate change is given the role of a contributor to, or trigger of, current challenges within the society. It is necessary to include these socio-economic factors, but two deficits can be identified in relation to how this approach has been used.

First, a vulnerability-driven approach reinforce a paternalistic approach whereby regions become passive and societal problems become fortified by adopting a discourse of 'winners-losers'. Second, this approach involves a tendency to a societal determinism where societies possibilities to develop are not recognised. Today's vulnerable regions are, accordingly, considered as tomorrow's vulnerable regions, which mirrors a static view on society. Implying a *ceteris paribus* where only the climate changes and there societies are held constant is a methodological flaw that leads to a deterministic view of society and societies' capability to change.[143] Framing the connection in this way could also lead to the fact that regions and societies considered stable today are overlooked.

Closely related to this determinism is the time-frame adopted in the analysis. First of all, one must recognise that time-frame seldom is explicitly mentioned. However, when analysing a phenomenon such as climate change it becomes evident that time-frame matters. In order to see any significant effects the time horizon needs to be decades and not years and even longer in order to distinguish more thoroughly between various climate scenarios. By adopting longer time-frames it becomes evident that societies have great possibilities to change in various directions and in ways that are not predetermined.[144] Longer time-frames are, however, difficult to adopt, but cannot be set aside. Instead the analysis needs to be open to different possible futures where scenario analysis might be

[141] Wolf 2007
[142] As for example in Carius et al. 2008; Maas et al. 2010; IISS 2011
[143] See e.g. Johansson 2010; Brzoska 2009.
[144] For example sudden uprisings in North Africa in the Arab Spring or rapid technological development in terms of water cleaning mechanisms or more climate-resilient crops in agriculture.

one approach. Due to the interest in security implications it is, furthermore, remarkable how little interest there are in analysing a greater spectrum of climate change scenarios. This not least since the security implications can be expected to be greater in more extreme climate scenarios in comparisons to moderate climate change scenarios.[145]

Biophysical exposure and socio-economic vulnerabilities represent two different starting points (i.e. impact-driven or vulnerability-driven, respectively). Coming back to the regional analysis within the studies, it is clear that they are mostly based on the latter approach, where socio-economic vulnerabilities are the major focus. Despite the importance of the starting point, almost none of the studies explicitly clarify its point of view and how this could have affected the conclusions drawn in terms of specific security implications.

4.1.2 Additional factors

In addition to biophysical exposure and socio-economic vulnerabilities two other aspects has been considered vital in the analysis, i.e. *environmental degradation*, which particularly refers to non-climate factors but which are to various degree affected by climate change, and *a history of violence.* The latter does not, in contrast to the other three aspects, emphasise future predictions but considers the role that history could play in the outbreak of conflict.

In the studies included in this analysis, it is clear that both these additional aspects are given some attention. Deforestation and over-grazing are frequently used as examples of problems closely connected to climate change and that it could lead to further environmental degradation. However, the degradation might also be the case even without climate change as non-sustainable agricultural practices also trigger water stress and conflict through overuse or contamination of water sources.[146] As such, it is important to consider time-perspectives and to recognise what happens and when, but also that the specific cause are not critical dealing with the consequences.

In terms of the historical context it becomes important analysing future conflicts risks as history of violence are an important factor in many conflicts. It is important to bear in mind here, in accordance with the deterministic view mentioned above, that a country's history is not static but changes as society develops and the analysis therefore needs to include the window of opportunities that might be opened due to the impacts of climate change (at least in some regions). Thus, there are important lessons to draw from the research on disasters and water scarcities that show that these events or scarcities also lies as a

[145] This matter is discussed by, e.g. Mabey et al. 2011; Mobjörk et al. 2010; Trombetta 2009
[146] As presented in the series of reports conducted by ENVSEC (2003;2007)

background for cooperation and even a de-escalation of conflict as was the case in Aceh after the tsunami hit in 2004.[147]

4.1.3 The contested scientific field

The connection between climate change and security is a contested scientific field. Conflicts that had previously been identified as being rooted in ethnic violence are now being placed in a new light. For example, some scholars now argue that the genocide in Rwanda in 1994 was in fact triggered by gradual soil erosion, which led to impoverishment among the citizens.[148] Similar discussions can be found regarding the on-going conflict in Darfur, with some arguing that climate change is the principal cause of the conflict and others that the social factor must be placed at the centre.[149]

Why, then, do single case studies such as those regarding Rwanda and Darfur, as well as more comprehensive and systematic quantitative large-N studies, fail to provide valid empirical evidence of the mechanisms behind climate change and conflict? A possible answer to that question is that almost all previous studies have had an exclusive focus on armed rebellion against *the state*, even though many of the estimated problems in the future, such as resource scarcity, represent a rise in *inter-group tension* and violence directed against other societal groups rather than agents of the state.[150] Thus, armed rebellion groups attacking the state in order to secure livelihood or increase economic standards would only be motivated if the state actually has the power to redistribute resources. This might not be the case in many of the regions identified as vulnerable, where institutional and governmental capacity is low.

An example of tension within, rather than between, states can be found in the Nile region, where competition for scarce water resources between upstream and downstream countries could very well have provoked interstate conflict but has not yet done so. Instead, it is more common for the countries involved to negotiate agreements over water supplies, such as the Nile Basin Initiative. This is also the case in the basin of the river Indus, which is shared between India and Pakistan. There the Indus Water Treaty, agreed in 1960, has proven to be a point of rare cooperation between two actors with a long history of conflict.[151] Within each country, however, disputes and tension exist due to clash of interests on whether to divert the water flow for electricity production through dams, or to use water sources for irrigation needs. This matter calls for further attention on

[147] Schubert et al. 2008:107. See also Wolf 2007; Gleditsch et al. 2006
[148] Bigagaza 2002; Gasana 2002
[149] See e.g. Faris 2007 against de Waal 2007
[150] Fjelde and von Uexkull 2011. See also Theisen 2008
[151] IISS 2011:16

the possible differences in consequences depending on scale and whether the conflicting interest is a matter internationally or domestic.[152]

4.2 Summing up and the road ahead

This report consists of an analysis of nine published studies that address the security implications following climate change on specific regions. The four overarching questions posed in the introduction concerned the impacts of climate change, the time-frames and scenarios used, the specific security implications, and additional aspects in terms of transformation processes or converging trends.

Regarding the impacts of climate change, it became evident that the nine studies analysed regard climate change as being a gradual process, which primarily has an impact on the availability of natural resources. This could be a gradual decline leading to water stress or unfavourable conditions for food production due to changes in precipitation. However some examples are provided where climate change could lead to liberation of resources, such as in the Arctic or increased agricultural yield, such as in Ukraine. When extreme weather events are considered, these mostly relate to flooding and the effects this could have on migration, but a major problem in many of the studies is the lack of explicit time-frames and climate scenarios adopted when presenting these effects.

The security implications that are addressed in the studies relate to human security, for example food insecurity and loss of livelihood, and a state-centric approach with the focus on strategic resources such as energy and the proportion of GDP coming from the agricultural sector. However, the linkages between these aspects and how insecurity at one level could lead to a security risk on the other are weakly argued throughout the studies with the exception of Schubert et al., who present some distinct conflict constellations where specific conflict dynamics related to climate change are highlighted. Most of the analysis stops at explaining that a certain impact of climate change could lead to an increase in migration and pose a threat to human security, but not how this in turn could trigger conflict in the target states.

In terms of additional transformation processes or converging trends, both population growth and continued urbanisation are considered to become major challenges. As the demand for energy continues to rise, additional pressure may also be put on the water resources needed today for irrigation.

As the regional analysis in this report reveal is the starting point in the analysis important for what security implications that is recognised in a certain region. Several factors interact and countries facing similar threats can, and will, have very different ability and resources to cope with these. When trying to identify

[152] See Wolf 2007

future hotspots of climate change it is therefore important to look at a wide range of climate scenarios in order to identify the effects of climate change that may actually be imminent, but it is perhaps even more important to consider different scenarios for societies' development as the adaptive capacity in the present may be altered in the future and that adaptive capacity both can be reinforced and be lost.

Education, economic growth, early warning systems and well-defined property rights are all good examples of socio-economic factors that could have an influence on a certain region's vulnerability or resilience to the effects of climate change. This also relates to the importance of the security approach adopted in the study, since the studies analysed rarely show how human security and a state-centric approach interact and how insecurity at one level can have an impact on the other. Certain gaps in research have been observed, which lay as a foundation for identifying some future research areas:

- Improve the research on what drives conflict and cooperation due to altered resources and disasters and improve the analysis of the importance of scale, i.e. the importance of the dimension domestic-international. Crucial here is the dependencies between effects following climate change and other transformation processes as well as the importance of the expectations and notions humans have on threat, risks and possibilities.
- Case-specific analysis of the security implications of climate change, both concerning regions often recognised as particularly vulnerable, such as coastal areas in Asia, semi-dry areas in Africa and regions around large rivers, as well as those parts that are given less attention such as south-east Europe and states in Indian-Pacific Ocean.
- Adopt a greater span in climate change scenarios including extreme, or worst-case, climate scenarios as they are important in preparing societies for the unlikely, but possible, effects. This approach is particularly important in areas of long-term social planning and crisis management as well as in security and defence analysis.
- Improve and develop a risk analysis methodology adequate for the security risks posed by climate change. This methodology needs to be able to cope with the interconnectedness between various security implications, i.e. state security and human security, as well as the long time frames needed, but also with the interconnection between different transformation processes and the fundamental uncertainties regarding both climate change and the development of societies.

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