The Economics of Planetary Security

Climate Change as an Economic Conflict Factor

Michel Rademaker
Karlijn Jans
Christopher Frattina della Frattina
Hannes Rõõs
Stephan Slingerland
Alexander Borum
Louise van Schaik

The Hague Centre for Strategic Studies

Clingendael
Netherlands Institute of International Relations

Planetary Security
INITIATIVE

The Economics of Planetary Security

Climate Change as an Economic Conflict Factor

Michel Rademaker, Karlijn Jans, Christopher Frattina della Frattina, Hannes Rõõs (*The Hague* Centre for Strategic Studies)

Stephan Slingerland, Alexander Borum, Louise van Schaik (Netherlands Institute for International Relations Clingendael)

November 2016

November 2016

Cover photo: Bucket wheel excavator used for brown coal mining © Pexels

About the authors

Michel Rademaker is the Deputy Director of HCSS responsible for project development and operations.

Karlijn Jans is a strategic analyst at HCSS.

Christopher Frattina della Frattina is an assistant analyst at the HCSS.

Hannes Rõõs is a Data Scientist at HCSS.

Alexander Borum is a Research & Project assistant at Clingendael.

Louise van Schaik is Senior Research Fellow and Coordinator of the Knowledge Group EU in the World at Clingendael.

Stephan Slingerland is a senior researcher and policy advisor focusing on the international transition towards a more sustainable world order.

About the Clingendael Institute
The Netherlands Institute of International Relations 'Clingendael' aims to enhance and deepen knowledge and opinion shaping on issues related to international affairs. The Institute realizes this objective through its research, training and consultancy for national and international parties. The Institute publishes reports and policy briefs, holds numerous conferences and publishes the digital magazine Internationale Spectator. Every year Clingendael offers a wide spectrum of courses and programmes, training hundreds of diplomats, civil servants, and other professionals from all over the world. For further info, please view: www.clingendael.nl

About HCSS
HCSS helps governments, non-governmental organizations and the private sector to understand the fast-changing environment and seeks to anticipate the challenges of the future with practical policy solutions and advice. For further info, please view: www.hcss.nl

About the Planetary Security Initiative
The Planetary Security Initiative aims to help increase awareness, to deepen knowledge, and to develop and promote policies and good practice guidance to help governments, the private sector and international institutions better secure peace and cooperation in times of climate change and global environmental challenges.

Follow us on social media
@PlanSecu
The Planetary Security Initiative
The Planetary Security Initiative

Email: psi@clingendael.nl
Website: www.planetarysecurityinitiative.org

Contents

Executive Summary

Introduction and objectives

Planetary security refers to the role of the environment in geopolitical risks and conflicts. As a relatively underexplored concept, this report, intended for policy makers and business professionals, examines the economic aspects of planetary security and, in particular, the vulnerabilities and resilience of countries to environmentally induced conflict. It first discusses the concept of planetary security and the role of economics therein, and then builds a quantitative framework and monitor capturing the vulnerabilities and resilience of different countries.

The report distinguishes between direct economic effects of climate change on countries, unintended economic effects of climate change policies and effects of climate change on business and financial sectors. While the first two elements are captured in the monitor and quantitative framework, the third element– the effects of climate change on business and financial sectors – could not yet be modelled in the monitor. This report therefore discusses the links between the economics of climate change and international conflict risk, which are brought together under the title 'economics of planetary security.'

Quantitative framework

The quantitative framework is divided into four different layers. Each layer is built on various individual variables and based on existing analyses of these variables which together constitute the substantial value of each layer. The first layer focuses on Conflict Vulnerability, the second on Climate Change Vulnerability, the third on Low Carbon Risk and the fourth on Economic Resilience.

These layers were then combined to provide a Consolidated Risk Layer, which consists of Layer One to Three, and a Consolidated Resilience Layer, combining all four layers in order to show how resilience to the above vulnerabilities could be bolstered.

Results

Figure 1 An Image of the Consolidated Risk Layer. You can find this on the Planetary Security Monitor.

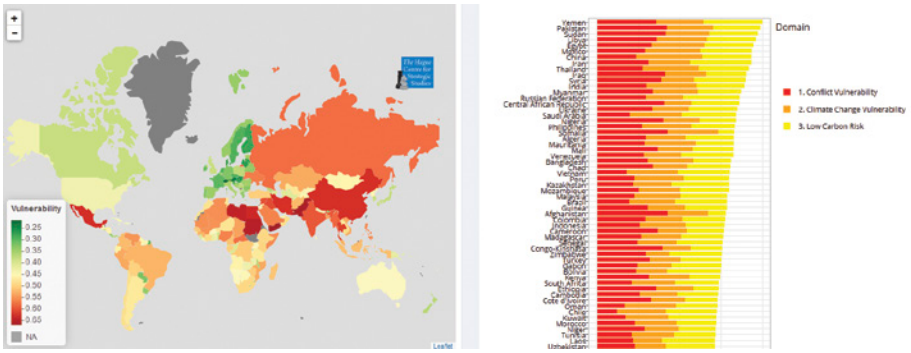
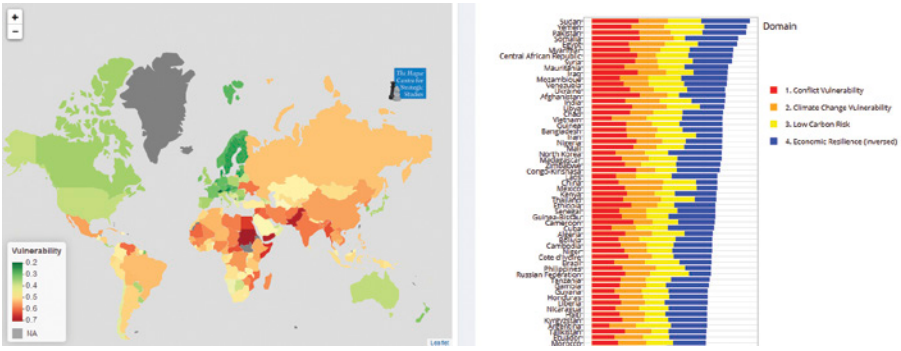


Figure 1 contains an Image of the Consolidated Risk Layer. This can be found online. Based on this image, it is evident that Europe stands out as the least vulnerable continent. Africa scores mostly on the medium to high vulnerability range, with the exception of North-Eastern Africa which predominantly scores in the high vulnerability range. South America has predominantly low vulnerability scores. North America generally scores in the medium to low vulnerability range. Meanwhile, Asia scores in the medium to high vulnerability range, with the exception of Japan and Bhutan. Oceania scores mostly in the medium to low vulnerability range. The variety in the scores are mainly derived from the different scores per country per layer. Taken together, most of the high scores are attributed to the Conflict Vulnerability Layer, which explains why the Middle East and North Africa region scores extremely high.

Figure 2 An Image of the Consolidated Resilience Layer



The Consolidated Resilience Layer in Figure 2 illustrates the degree of overall resilience to conflict. When reviewed against the Consolidated Risk Layer, the scores do not look quite so bleak: for instance, many states which are at risk have some economic capabilities to assist in mitigating such risks. With the exception of a few countries, the overall average score ranges in the medium resilience range. With respect to the Consolidated Risk Layer (Figure 1), Asia fares better as it drops from being predominantly in the medium to high risk range to the medium risk range; this is however with the exception of Japan and South Korea both scoring low, and Pakistan and Yemen both scoring high. Africa continues this general trend, with most countries occupying the medium scoring range. This bodes well considering its high dependence on fossil fuel rents. Sudan has the highest consolidated score.

Conclusions and Recommendations

The report provides various examples of how the monitor could be used by policy makers and the business sector. Based on the monitor, three categories of countries were identified which would require different types of action from policy makers and business professionals:

Category A – Peace First, Development and Climate Resilience Later

These countries experience high conflict vulnerability, high environmental stress, low economic resilience, and are usually affected by war. For these countries, conflict is the overriding risk factor. The following are our recommendations:

1. Improve country resilience by identifying and addressing underlying pressures, feeding into tailored and precise policy making;
2. Investigate and identify joint responses for public authorities and the private sector in managing the process of conflict transition.

Category B – Economies at Risk in a Low-Carbon World

These countries are heavily invested in carbon and non-renewable energy, with the export of fossil fuels often a key ingredient in maintaining economic prosperity. The following are our recommendations:

1. Identify, address and align climate change policy and the transition towards a low-carbon economy, while addressing and streamlining actions combatting climate change effects;
2. Develop capacities for economic resilience: introduce policies transitioning to a low carbon economy. This is both an opportunity and challenge to both the public and private sector;
3. Diversify the economies of fossil fuel dependent countries, especially those in the MENA region prone to conflict. For more economically resilient countries and transnational corporations: develop tailor-made capacities or support for such countries.

Category C – Synthesizing Climate Change Mitigation with Development

These countries possess a strong economical basis with which they can develop policies that address both climate change resilience and development schemes. The following are our recommendations:

1. Undertake a domestic analysis of the causes of maladies in the particular country's current situation to ensure policies are more effective. Policies have to address the driving factors of the different layers of risk in the monitor.
2. Prevent climate change mitigation and adaptation policies from becoming a new source of conflict through, for instance, addressing stove piping of climate change policies. This feeds into the need for comprehensive and balanced policies.

Introduction

Background

Planetary Security refers to the intricate relationship between the environment and conflict, with the former often acting as a stress factor to the latter. Within this relationship, economics often has a crucial role to play. In the face of a rapidly-changing geopolitical landscape, contemporary perspectives on security have drastically changed in reaction to new conflict factors that have arisen out of, and are related to, unpredictable patterns of climate change. Terrorism and small-to-large scale disputes between nations and ethnic groups, and the recent economic and financial crisis of 2008, have shaken the confidence of many in the robustness of international relations, and in the global financial system. In addition to this, the potential risks of climate change give impetus to the rise of unease and uncertainty as to how the future of the world will eventually take shape. This bears more weight as fundamental changes on a global level hardly ever come about smoothly and are likely to have far-reaching effects. Already, in both the short and long term future, it is increasingly likely that conflict will result from a multitude of stress factors. Environmental stress, and in particular stress caused by climate change, is only one of these factors. Nonetheless, in light of its diverse and multiplier impacts, it remains an important one.

Since the advent of the 21st century, the debate over the adverse effects of climate change has taken on an increasingly important role in contemporary political discourse. Early climate change discussions focused heavily on the results of the seminal 1998 hockey stick graph[1], which was essentially a reconstruction of the changes in average temperature levels since the year 1400.[2] Later, climate change political discourse turned to examine its economic effects in more detail. Key reports such as the review by Lord Nicholas Stern outlined grim scenarios where the global economy would suffer from a permanent state of depression by 2050[3] due to the adverse effects of climate

1 "*This refers to the shape of a graph where one variable rises steadily over a period of time and then dramatically increases towards the end of the period. The shape resembles an ice hockey stick blade*" (Chan, 2016).

2 (Mann, Bradley, & Hughes, 1998).

3 (Stern, 2006).

change.[4] The Stern Review has since been followed by a large number of specialized, yet supportive, studies into the economic effects of climate change.[5]

The economics of planetary security is a concept still in its infancy. The concept has two dimensions: The first dimension recognizes the economics of planetary security as an interconnected system of climate change, the economy and conflict, and their negative domestic and international impacts. It also includes the ability of public and private actors to mitigate the effects of stress factors in a given country. The second dimension is addressed in our monitor, which quantifies the reactive policy capacities of public and private actors through the incorporation of economic data.

The second dimension captures this, taking the term 'economic' in its numerical form. The basis of this monitor is a multi-layered quantitative framework, with each layer illustrating core tenets of the economics of planetary security as a system. These layers include a given country's vulnerability to both climate change and conflict, their dependency on non-renewable energy sources, and their economic ability to mitigate the negative effects of these vulnerabilities and dependencies. The monitor increases risk awareness and provides data-driven information on, for instance, the economic preparedness of countries with regard to their ability to combat climate change stress and minimize its capacity to catalyze conflict and economic upheaval.

Conflict risk and the economics of climate change, although heavily studied, have not yet been systematically linked. The supporting evidence that climate change is likely to bring about changes in the global economic system, and subsequently increase conflict and investment risk, highlights the need for such a systematic analysis. If reactions to climate change are not coordinated correctly they could – in their own right – result in unexpected economic changes, and in turn contribute to conflict risk.

Report Aim and Structure

This report examines the economics of planetary security by focusing on climate change as a stress factor for conflict and its intricate relationship with various societal sectors. The intended audience of this report is policymakers as well as stakeholders from the private sector. By using the conceptual framework put forward in the first half of the report as a lens through which to view the data in the latter half of the report, recommendations are generated which aim to elucidate how to increase resilience to climate change-induced stress at a state, environmental and

4 (Stewart & Elliott, 2013).

5 (Eliasch, 2008), (TEEB, 2010), (Goulder & Pizer, 2006), (ADB, 2013), (Downing, Watkiss, Dyszynski, Butterfield, Devisscher, & Pye, 2009).

economic level. The report consists of two main parts: Chapters 2 to 4 qualitatively discuss the economics of climate change as a policy topic. Building on that discussion, chapters 5 and 6 then introduce an experimental quantitative framework for analyzing vulnerabilities and economic resilience to climate change induced conflict. Chapter 7 gives overall conclusions and policy recommendations, and outlines the need for further research on the framework in the future. The monitor in its current form is an investigation into the economics of planetary security. Using the conceptual outline in the first half of the report as a lens through which to view the data, the indicators were operationalized to give a holistic understanding of the complexity of the economics of planetary security. The purpose of this report and monitor is to provide policymakers and business professionals alike with a basic contextualization of the factors that need to be incorporated when creating both policies and business plans related to climate change.

1 Environmental Stress as a Conflict Factor

This chapter discusses the effects of climate change on both present and future conflicts by focusing on a contemporary general explanation of their causes. It also provides a structural understanding of the impact of climate change induced stress on traditional and non-traditional security risks. Before turning to the economics of planetary security in chapter 4, this chapter discusses some key underlying concepts regarding how environmental stress can impact both traditional and non-traditional security threats. Environmental stress denotes both human and naturally induced pressure on the environment. As a subset of this, stress caused by climate change refers to negative environmental impacts caused by gradual changes in atmospheric conditions.

Conflict, Vulnerability and Resilience

Conflict, in its overall sense, is an umbrella-term which can cover anything from interpersonal disagreements to total war scenarios. When considering this term in a planetary security framework, 'conflict' in the first place refers to 'armed conflict'. In the same vein, climate change as a conflict factor becomes the subject of foreign and defense policies. Moreover, in developing nations with inefficient systems of governance, armed conflict and climate change could also be the subject of development policies. Nonetheless, when discussing the economics of planetary security, the term 'conflict' cannot be limited to 'armed conflict' only. Rather, the potential effects of climate change on the global economic system as a whole should also be considered. In expanding the definition of 'conflict' to include 'economic conflict', the term enters the realm of international economic policies.

New Forms of Armed conflict

In looking at armed conflict, balancing the scale of conflict with the complexities of modern warfare is necessary. This approach necessitates an openness for both traditional and non-traditional considerations, such as the inclusive fourth-generation warfare theory first introduced by William S. Lind in 1989 and later expanded upon by Colonel Thomas X. Hammes.[6] It comprises the various actors involved in modern warfare

6 (Lind, Nightengale, Schmitt, Sutton, & Wilson, 1989), (Hammes, 2006).

today, digressing further from the centralized model inherent in the 20th century. Fourth-generation theory builds upon a historical framework of military engagements and addresses the shift between traditional interstate warfare and present unconventional non-state types of warfare. The former focuses on a centralized model where the state has a complete monopoly on violence. Alternatively, unconventional types of warfare comprise a more complex and decentralized form of conflict in which the appearance of non-state actors has changed the nature of conflict. The insurgency in Syria is a key example of such a contemporary, complex scenario, as it includes multiple conflict areas and prolonged conflicts between insurgent groups and coalitions of both national and international forces, as well as conflict by non-traditional means, such as terrorist attacks, covert operations and economic pressure. This supports the inclusion of both the Terrorism Index and Best Estimate Death Toll in Layer One's subdomain on Security (see section five).

Economic conflict

Economic conflict can be induced by environmental stress by either contributing to changes in the global economic system which impact the system as a whole (e.g a 'collapse' of global banking infrastructure) or by influencing the existing balance within a state's economy. The latter includes how environmental stress induces measures like trade embargoes, boycotts, sanctions, tariff discrimination, the freezing of capital assets, the suspension of aid, the prohibition of investment and other capital flows, and expropriation.[7] In this respect, economic conflict runs the risk of being a precursor to armed conflict.

Conflict Vulnerability and Resilience

'Vulnerability' and 'resilience' to conflict remain important to the discussion of the economics of planetary security. Vulnerability is defined here in general terms as "[t]he propensity or predisposition to be adversely affected"[8] and resilience as "[the] degree to which a system rebounds, recoups, or recovers from a stimulus."[9] This report examines factors that make nations 'vulnerable' or 'resilient' to conflict. As such, these two terms can be regarded as their inverse: nations that address the factors that make them less vulnerable to conflict by way of policies become more resilient to such conflict. Yet, building conflict resilience might encompass more than only addressing vulnerability factors on a national level. In particular, when looking at economic conflict, building resilience might also involve taking measures on a supranational level in order to prevent systemic risks induced by conflict factors that include climate change.

7 (Shambough, 2016).

8 (Oppenheimer, Warren, Birkmann, Luber, O´Neil, & Takahashi, 2014).

9 (IPCC-SEC, 2016).

Factors Contributing to Conflict

Conflicts are based around an asymmetrical fulfilment of needs and interests between two or more parties. These perceived injustices or unmet needs will often be based on disputes over resources or disagreements over political, ideological, religious, ethnic or cultural differences between parties. Contemporary scholars such as Collier, Coleman, Fetherston and Nordstrom[10] have attempted to categorize these needs and interests into distributional and identity-related issues.[11] Distributional issues are directly tied to fair resource allocation, whereas identity-related issues are typically based around colliding interests between parties that often have strong religious, cultural, ideological or ethnic divisions. Figure three elucidates the importance of distributional and identity-related issues as underlying causes of conflict. This distinction is used here to allow policymakers to understand the potential distributional and identity-related issues inherent in the monitor. For instance, Ethnical Fractionalization and Factionalism in Layer One could be taken as an instantiation of the likelihood of conflict to be caused by identity-related issues. Distributional issues can be inferred from the water, land and precipitation subdomains in Layer Two.

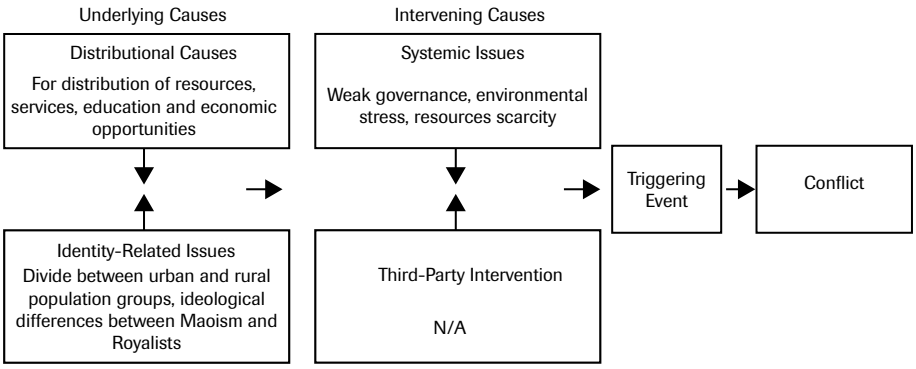
Alone, these underlying causes are insufficient to trigger a full-scale conflict, but they will typically create higher levels of tension between parties and amplify the overall risk of conflict. Typically, intervening causes of a systemic or external nature serving as onflict catalysts will be made clearer.[12]

10 (Schaik & Dinnissen, 2014).

11 (Collier, Elliott, Hegre, Hoeffler, Reynal-Querol, & Sambanis, 2003), (Coleman, Deutch, & Marcus, 2014), (Fetherston & Nordstrom, 1995). See (Douma, 2003, pp. 45-176) for a more comprehensive list of potential conflict factors.

12 (Schaik & Dinnissen, 2014).

Figure 3 Causes for Conflict (van Schaik and Dinnissen[13])



The Maoist uprising in Nepal

Distributional issues contributed to the outbreak of the Maoist uprising in **Nepal**[14] during the mid-nineties. Concerns over the accessibility of resources, services, education and economic opportunities created a schism between urban and rural populations. This initial schism eventually enabled widespread rural support for an insurgency that had been born out of the identity-related issues. Distributional issues were linked with identity related issues ingrained in the Maoist movement in Nepal, and these were exploited to further divide city dwellers and farmers, thus garnering support for the Communist movement to oppose the Nepalese royalists.

In this case a link between the systemic weak governance of the state on the one hand (due to inefficient resource distribution) and other factors such as the impact of environmental stress and resource scarcity on the other is highly noticeable. This corroborates the assumption that weakened states prove more susceptible to conflict risks in comparison to more efficiently governed ones. Such concerns may also be aggravated by externalities such as third party interference in the form of military aggression, geopolitical pressure, or other forms of external intervention.[15]

13 (Collier & Hoeffler, 2004), (Coleman, Deutch, & Marcus, 2014), (Fetherston & Nordstrom, 1995).

14 (Schweithelm, Kanaan, & Yonzon, Confilict over Natural Resources at the Community Level in Nepal - Including its Relationship to Armed Conflict, 2006).

15 (Schaik & Dinnissen, 2014).

Several research organizations – such as the Centre of Systemic Peace, IHS Markit, the EU's Conflict Risk Index and Visions of Humanity – have developed conflict monitoring systems that distinguish between a variety of factors contributing to armed conflict in general.[16] The detailed Conflict Vulnerability Monitor used in this report is built by the Hague Centre of Strategic Studies[17] and takes into account a large number of security, political, social and demographic factors, providing a holistic picture of the forces which underpin policy making with regard to conflict.[18]

Climate Change as a Conflict Factor

Environmental stress has overtime become increasingly interpreted as a systemic factor which contributes to conflict.[19] Such stress is not necessarily attributed to climate change alone. Correlations between resource availability, management and extraction processes as prime examples of potential conflict risks are evident. Here, the mismanagement of resources has a tendency to catalyze distributional issues involving government inefficiency, societal divides and increased authoritarianism – issues that all raise concerns for human security.[20] Furthermore, potentially rich national endowments in resources in weak states might contribute to conflict risk, as the wide academic debate around the 'resource curse' has shown.[21] The relationship between climate change and conflict is even more complex than the aforementioned suggests. In a limited number of cases, environmental stress has even contributed to conflict mitigation or resolution, for instance in the case of the 1994 drought in Mozambique, which weakened the Renamo rebels and expedited the peace process.[22]

16 E.g. the IHS conflict monitor (https://www.ihs.com/products/conflictmonitor.html); the BICC resource conflict monitor (http://archive.bicc.de/rcm), the IISS armed conflict database (https://acd.iiss.org/) and others.

17 Built on the HCSS (2016) Drivers of Vulnerability Monitor, http://projects.hcss.nl/monitor.

18 See Chapter 5.

19 See following source for in-depth analysis on the role of environmental stress as a conflict factor: (Femia & Werrel, 2012).

20 (Alao, 2007), (World Commission on Environment and Development, 1987).

21 See e.g. Ross, Michael L. (1999). "The Political Economy of the Resource Curse". World Politics. 51 (2): 297–322 and Ross, Michael L. (2015) "What Have We Learned about the Resource Curse?". Annual Review of Political Science. 18: 239–259.

22 ODI (2013) When disasters and conflicts collide - Improving links between disaster resilience and conflict prevention, London.

Over recent years, discussions regarding conflict risk and environmental stress have predominantly focused on the potential effects of climate change. Such effects, while traditionally understood on a domestic level, have increasingly become framed as a global concern both on the basis of their consequences and the mitigative measures that need to be levelled against them. Similarly, policymakers and academics increasingly recognize climate change as a threat multiplier. This has been reflected in many recent publications and reports that have sought to analyze the threats posed by climate-induced environmental stress. Rüttinger et al. (2015) for instance identify several critical climate-fragility risks that pose threats to the stability of states in the decades ahead, ranging from local resource competition to the unintended effects of climate policies.[23] Based on these risks, the report considers 19 nations, most of them situated in Africa, as most vulnerable to climate change as a conflict factor. However this analysis is primarily focused on the direct impacts of climate change and does not look into the indirect contribution of climate change to conflict via the international economic system; nor does it examine in more detail the potential adverse impacts of low-carbon and climate change policies to international security.

The emphasis in this new branch of research is generally on the identification of new vulnerabilities, the aggravation of existing risks and the subsequent contributions to the onset of instability and conflict as a result of climate change.[24] This research ultimately stresses that the threat posed by climate change can contribute to conflict in vulnerable nations by enhancing both the risk and the intensity of conflicts, without necessarily being the direct cause of them.[25] Such effects have been noticed for instance in the ongoing conflicts in the MENA and Sahel regions. This puts vulnerable states at risk of repeating a history similar to that of Darfur, Sudan's westernmost region.[26]

23 (Rüttinger, 2015).

24 (U.S. Department of Defense, 2015), (Henderson, Song, & Joffe, 2016), (Strategiya natsional'noy bezopasnosti Rossiyskoy Federatsii [Strategy on national security of the Russian Federation], 2015), (UNIFTPA, 2012), (NATO Parliamentary Assembly, 2015), (Rüttinger, et al., 2015).

25 (Schleussner, Donges, Donner, & Schellnhuber, 2016), (Rüttinger, et al., 2015), (National Intelligence Council, 2012), (Kelley, Mohtadi, Cane, Seager, & Kushnir, 2015).

26 (Manger, 2006), (Salih, 2005).

Ethnic Clashes in Darfur

During the mid-seventies to the mid-eighties the Darfur region suffered from a series of particularly harsh droughts, resulting in famine and increased tensions over access to arable grazing land.[27] The environmental degradation caused by the extreme temperatures underlined key *distributional issues* in the region, where the typically Arab *Rezeigat / Baqqara* herders of northern Darfur were unable to access the scarce water resources that the more Afro farmers – such as the *Masalit* and *Fur*- in Central/South Darfur were given access to. These issues catalyzed the ongoing *identity-related issues* and widened the cultural divide, leading to numerous clashes between those with Arab ancestry and those of African roots. These issues proved to be catastrophic in a region already suffering from widespread poverty between the predominantly rural populations, consisting mostly of subsistence farmers, and the lack of local governance in the state to address these concerns. These ongoing issues and the impacts on the regional economy by environmental stress would eventually create a contributing factor for the escalation into long-term violence in Darfur.

27 (Owen, 2004), (Rüttinger, et al., 2015).

2 The Economics of Climate Change as a Conflict Factor

The economic impacts of armed conflict can be enormous. Earlier this year the Institute for Economics and Peace released the 2016 Global Peace Index[28], providing an estimate of $742 billion as the value set for the global economic impact of armed conflicts in 2015.[29] Independent from conflict, climate change also has large economic impacts. In the 2006 Stern Report it was estimated that long-term costs of climate change will be equivalent to losing at least 5% of global GDP each year and, if a wider range of risks and impacts were taken into account, the estimates of damage will rise to 20% of GDP or more.[30] In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year.[31]

Many links between climate change and conflict have economic elements: they impact conflict risk by affecting the distribution of resources. Here, the difference between three general routes of economic impacts of climate change contributing to conflict will be expanded on in the following section. In the first route, climate change has direct effects on the economy of countries by intensifying land, water and resource scarcities. In the second route, climate change has indirect impacts on the economies of countries by affecting international business and the financial sector. Finally, a third route consists of indirect effects on the economies of countries as a result of unintended outcomes of climate change and low-carbon policies.

Directly or indirectly, all three have an impact on conflict risk by increasing the vulnerabilities of nations as indicated in Figure 4, especially when this economic vulnerability is coupled with other conflict factors, such as those described under Figure 1. As a consequence, a notable increase in conflict risks is anticipated.

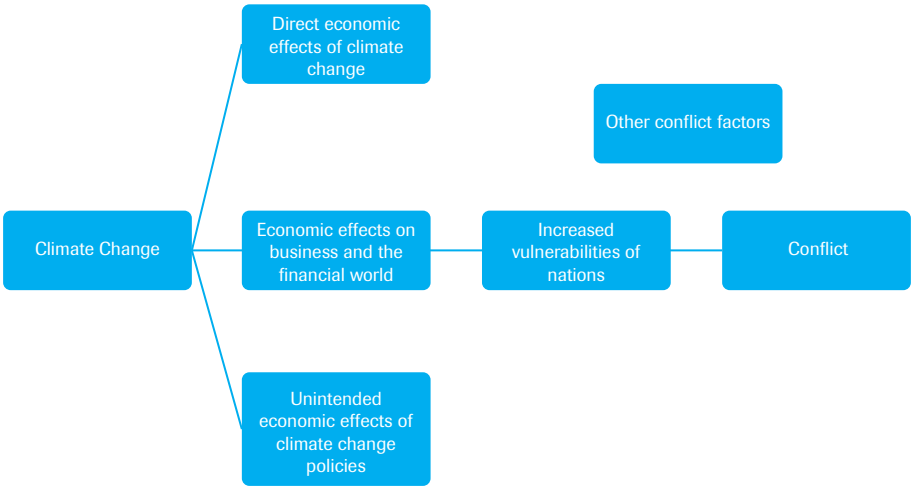
28 (Institute for Economics & Peace, 2016).

29 (Institute for Economics & Peace, 2016).

30 Stern, N. (2006) Stern Review Report on the Economics of Climate Change. HM Treasury.

31 Stern, N. (2006) Stern Review Report on the Economics of Climate Change. HM Treasury.

Figure 4 Economic effects of climate change in relation to conflict risk conduct by Clingendael



Direct effects of climate change on countries

Direct climate change effects can increase the risk of conflict in a country. Factors include, for instance, those identified by Rüttinger et al. (2015). All of these factors have economic implications that contribute to increased vulnerability of nations, which in turn can lead to conflict (See Table 1).

Table 1 Economic implications of climate conflict factors based on Rüttinger et al. (2015)

Climate Conflict Factors	Economic implications
1. Local resource competition	Increased scarcity of land, water and other resources lead to higher market prices and unavailability of resources to certain groups.
2. Livelihood insecurity and migration	Higher population pressure (e.g. by migration to cities or to other countries) leads to increase scarcity of resources.
3. Extreme weather events and disasters	Destruction of infrastructure, facilities and homes will disrupt production and economic developments, with spill-over effects for local markets.
4. Volatile food prices and provision	Food riots will lead to disruption for the affected social capital and local businesses.
5. Transboundary water management	Mismatched interests in water management may severely affect water reliant sectors, and may further be a cause for unrest and tension.
6. Sea-level rise and coastal degradation	Costal businesses and industries may find key resources and infrastructures put under risk from environmental stress in their key areas.

Typically, the impacts of climate change will directly target three types of assets: physical, resource and social assets. Physical assets, such as factories, refineries or other corporate infrastructure investments, may be directly affected by extreme weather events. Access to resource assets, such as a new body of freshwater, might change due to engineered or climate related changes in domestic water levels. Finally, the unmet social needs of a domestic population due to, for example, high urban population pressure from migration, can easily cause large scale-economic disruption.[32]

Effects on Business and the Financial Sector

Climate change can also have severe impacts on the stability of the global economic and financial system. Two main processes are apparent, one of which is related to the increased instability of the financial system that comes as a result of increased disaster risk. This instability might lead to severe financial losses across insurance

32 (Avory, Cameron, Erickson, Fresia, & Davis, 2015) BSR suggests the following asset classifications. *Physical Assets* (infrastructure, equipment & vehicles), *Natural Assets* (biosphere, environment & resources), *Governance Assets* (political, legal and policy efforts), *Technological Assets* (information & communication), *Knowledge Assets* (know-how, skills development, expertise), *Social Assets* (social capital, civic networks) and *Financial Assets* (financial products, credit access, insurance).

and reinsurance companies, which could provoke bankruptcies and gravely affect the economic and financial system as a whole.[33]

The other process, also known as the 'carbon bubble', is the increased risk of investment in fossil fuel companies whose assets – in particular fossil fuel reserves – will depreciate substantially within a few decades as climate policies become stricter. The two processes combined result in the rise of several climate change risk factors to the business and financial world which, to a certain extent, can be attributed to individual countries. These risk factors include for instance total re-insurance capital, potential climate change affected re-insurance capital, imbalance in the size of the banking and financial sector compared to the overall economy and drastic changes in carbon assets in a country.

The Risks of Climate Disasters to the Insurance Sector

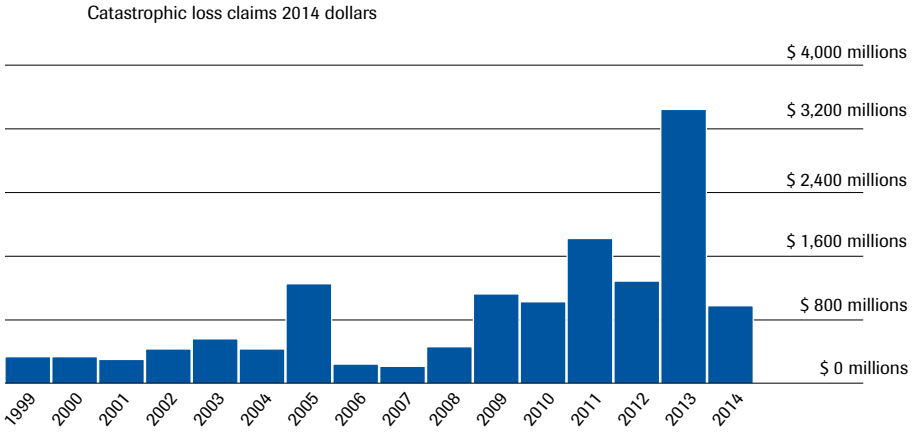
The link between the frequency of natural disasters and climate change has received renewed focus in the scientific community; as a result, the increase in interest in the insurance and re-insurance sector has followed suit, given the situation poses an immense risk for the sector as a whole.

Guided by these interests, the insurance and re-insurance sector has gradually positioned itself as an innovator in the private sector. This is a role that enables it to influence vulnerable industries, including through the ability to charge higher insurance premiums on risk-prone industries, or through ongoing risk analytics which provide frameworks for addressing concerns over the explicit impact of the liability of policyholders. As such, proactive approaches to resilience building to off-set risks of, for example, coastal properties and disaster prone regions can be addressed; meanwhile, risk prone, yet proactive, policy holders can be rewarded by lowered insurance premiums. Such efforts were noticed in the flood-prone areas of Alberta and Southern Ontario in Canada, where pay-outs for 'catastrophic loss' claims exceeded three billion Canadian dollars in recent years[34].

33 (Mills, 2007), (Munich RE, 2016).

34 (Nokes, 2015).

Figure 5 Catastrophic Loss claims, Insurance Bureau of Canada (Nokes, 2015)



Source: Insurance bureau of Canada

The gradual rise in pay-outs and the increased frequency of extreme weather floods caused the industry to invest resources into providing updated flood maps, and more research into flood impacts for the regions. Increased pressure placed upon policymakers and stakeholders, such as the Canadian Government, to invest in resilience building efforts resulted in a number of technical adaptions to regional, municipal and household infrastructures and paved the way for a public-private partnership to mitigate risks for both types of stakeholders.[35] Risks such as these also align with the private sector's interests in global mitigation efforts, given that investments into establishing low-carbon economies may halt the negative climate related developments and thus reduce the overall threat posed by climate change over time.

The Carbon Bubble as a risk factor for investments

With the publication of the 2011 report on 'Unburnable Carbon', a fierce debate started on the consequences of having to depreciate huge carbon assets worldwide that, as a result of climate policies, would become worthless.[36] The report stated that by 2011, the world had already used over a third of its 50-year carbon budget of 886 GtCO2, leaving a maximum of 565 GtCO2 to be burned in order to reach a 2-degree Celsius target. All of the reserves owned by private and public companies and governments

35 (Nokes, 2015), (Team Green Analytics, 2015).

36 Carbon Tracker (2011) Unburnable Carbon – Are the world's financial markets carrying a carbon bubble? http://www.carbontracker.org/report/carbon-bubble/.

were estimated to be equivalent to 2,795 GtCO2, meaning only 20% of the total reserves could be burned unabated; hence, 80% of assets would be technically 'unburnable' and therefore should be depreciated. This would leave the global financial sector with a huge 'carbon bubble.'

The discussion on what exactly falls under the 'burnable' or 'unburnable' fossil fuel categories continues. It is for instance argued that fossil fuels should be used based on their carbon content. That means that the reserves of gas, as a fuel with the lowest carbon content of the three sources, could still be used within the carbon budget; even using oil reserves would still fit to a certain extent within the budget on the condition that coal would be rapidly phased out.[37] Many public and private investment funds, however, have already announced that they will no longer invest in fossil fuels. For example, in 2014, the Rockefeller Brothers Fund announced their intention to divest from investments in fossil fuels;[38] In 2015, Norway's Pension Fund Global – the largest sovereign wealth fund worldwide ($850 bn.) – removed 114 coal companies from its portfolio[39]; And in 2016, Blackrock, the biggest private investment fund in the world ($4.9 trillion), announced that it considers climate change to be a source of portfolio risk which needs addressing. BlackRock will, therefore, "calculate greenhouse gas emissions as a percentage of a company's sales, estimate firms' exposures to income shocks from rising temperatures and calculate the sales a company generates with little physical waste."[40]

Unintended effects of climate change policies

Not only can climate change itself lead to conflict, but policies that aspire to mitigate or adapt to climate change can also unintentionally increase conflict risks. Three possible risk areas stand out here, namely: conflict risks caused by depriving countries of fossil fuel rents; conflict risks caused by affecting other resource rents of countries (due to import/export relations); and conflict risks caused by creating new dependencies of countries.

37 Clingendael International Energy Programme (2014) Transition? What Transition? The Hague.

38 Rockefeller Brothers Fund (2014) Divestment Statement, September 2014, http://www.rbf.org/about/divestment.

39 The Guardian (2015) World's biggest sovereign wealth fund dumps dozens of coal companies, 5 February 2015.

40 EnergyPostWeekly (2016) Blackrock rocks, 9 September 2016, http://energypostweekly.eu.

Conflict risk caused by depriving countries of fossil fuel rents

New global instabilities and conflict potentials might be introduced as a consequence of certain countries – mainly those dependent on fossil fuel rents for their national economy – being deprived of their main source of income as a result of climate policies. Some of these countries have high GDPs and can afford to diversify their economy to non-fossil fuel sectors. From our monitor, examples of these countries include Australia and Saudi Arabia.

Many other countries dependent on fossil fuel rents, however, are less fortunate. Some countries already suffer from internal unrest and will therefore be more likely to encounter large problems in adaptation. This applies to Botswana, Syria and Venezuela. This might also cause a particularly unstable situation in countries in the Middle East, where fossil fuel dependency combines with ongoing armed conflict, high population growth and youth unemployment, as well as religious fundamentalism. In Latin America, internal crises due to lower fossil rents might also contribute to conflict.

Conflict risk caused by affecting other resource rents of countries

Climate policies can also introduce new conflict risks when they affect other resource rents of countries in an unintended way. This holds, for instance, for forest-rich countries, in which the exploitation of the mostly rich biotic resources is particularly sensitive to conflict. Illegal logging, slash and burn policies and access of the poor to forest resources are some of the issues that need to be tackled when introducing conflict-sensitive REDD policies. The same rationale applies to biofuels exploitation, where areas newly used for fuel crops might deprive parts of the population of fertile grounds needed for food production.

Conflict risk caused by new dependencies of countries

A third category of conflict risk might be induced by new country resource dependencies as a result of climate policies. This might apply for new dependencies on rare earth metals necessary for high-tech renewable energy applications in solar panels or rotors of wind turbines. Applicable risk factors could include the number of countries highly dependent on fossil fuel rents, the number of countries highly dependent on other resource rents, the number of countries with a high biodiversity and forest cover or the number of countries having access to scarce minerals.

3 Building Climate Change Conflict Resilience

It is evident that addressing the root causes of conflict while addressing the impacts of climate change stress on the economy – and vice versa – remains difficult. Building climate change conflict resilience is therefore a challenging and arduous thing to achieve as policymakers and the private sector are tasked with integrating a plethora of various entities into the picture. Thinking larger and elaborating on the repercussions of policies is necessary. Based on the previous chapter, building climate change conflict resilience consists of a multi-layered challenge: Firstly, it consists of making nations more resilient to conflict in general. This means identifying and addressing underlying factors for conflict such as religious and social tensions as well as distributional inequalities. Secondly, climate change conflict resilience has to address the direct climate related factors that lead to environmental stress as a conflict multiplier. Thirdly, climate change conflict resilience should deal with the indirect effects of climate change on the business and financial world. Fourthly, climate mitigation and adaptation policies as new sources of conflict should be avoided. All of these measures bear important economic components. In this chapter, policies that can build general climate change conflict resilience are discussed, followed by a reflection on the specific economic dimension that is also necessary to build climate change conflict resilience.

Building overall conflict resilience

Some factors that make countries particularly vulnerable or resilient to conflicts cannot be influenced, such as their geographic position (e.g. being landlocked or not) or their degree of natural resource endowment. However, many other factors remain that can be influenced by policies. Building overall conflict resilience is generally recognized as consisting of several dimensions. The OECD for instance, distinguishes between four dimensions of a successful approach: societal, political, economic, environmental and, as a possible fifth dimension, security.[41] The need for a multi-faceted policy approach is also recognized in the HCSS Drivers of Vulnerability monitor.[42] These indicators suggest that for building general conflict resilience there are policies needed to address issues

41 OECD (2016) Towards a multidimensional concept of fragility, Working Paper describing a new way to frame fragility for the OECD, January 2016.

42 HCSS (2015) Drivers of Vulnerability Monitor, http://www.hcss.nl/dossiers/drivers-of-vulnerability-monitor/21/.

of security – including political violence, terror and refugee outflow –, politics – including civil liberties, political rights, government effectiveness, rule of law and corruption –, social and demographic – including education, female labour participation and fertility – and economic – GDP, exports, resource rents, inflation and trade openness.

While the scope of policies falling within these dimensions already seems wide-ranging, addressing environmental stress factors involves even more policies, and poses a more puzzling conflict landscape for researchers and policymakers alike.

Addressing direct climate change related stress factors

When looking specifically at environmental, resource and climate change related conflict, the above policies continue to apply, however more specific policy measures for resilience building can also be identified. These are often related to the resources themselves, to the resource user and to the 'rules' that govern the use of resources.[43] Young and Goldman (2015) for instance find several factors that can foster and strengthen relationships between former adversaries after a conflict that also involved the use of natural resources,[44] namely:

- *Strengthening governance institutions and improving natural resource management* can help to resolve disputes, promote equitable access to natural resources, and support sustainable economic opportunity and redevelopment.
- *Joint management of shared natural resources* can help conflict-affected communities move away from maladaptive livelihood strategies (esp. linked with intimidation, violence or destroying natural resources).
- *Increasing economic, educational and capacity-enhancing opportunities and social standing among previously disempowered demographic groups*, such as women and unemployed youth, can improve both livelihood security and empowerment among members of such groups.
- *Re-establishing financial services* (in particular, microfinance) and the flow of income can facilitate redevelopment.

A key design approach to determining specific resilience areas has been developed by The Global Facility for Disaster Reduction and Recovery (*GFDRR*), which uses five key instruments to address climate change resilience, namely *Identification*, *Reduction*, *Preparedness*, *Insurance* and *Recovery*.[45] Awareness of potential threats and anticipation

43 Ratner, B.D. et al., (2013). Resource conflict, collective action, and resilience: an analytical framework. International Journal of the Commons. 7(1), pp.183–208. DOI: http://doi.org/10.18352/ijc.276.

44 Young, H. and Goldman, L. (2015) Livelihoods, Natural Resources and Post-Conflict Peacebuilding, Routledge.

45 (The Global Facility for Disaster Reduction and Recovery, 2015).

of potential effects play a crucial role in this approach. Solutions, according to this approach, should be tailor-made rather than generic.

The understanding of the specific context of a conflict in which resource use and climate change play a role as conflict factors is vital to building resilience, and is also stressed by other authors. USAID (2015)[46] write that context, institutional performance and understanding key actors are crucial for resolving such conflicts. Vivekananda et al. (2014) underline that understanding the local variation of societies, the "contextual complexities," should be the first step for any resilience-building operation. In their view, local and national-level dynamics need to be considered in tandem to understand how changes in one place might have effects elsewhere.[47]

Rüttinger et al. (2015) stress the importance of integrated approaches to address climate change as a conflict factor. In doing so, they believe that the international community will be better equipped to mitigate its interconnected risks while realizing important co-benefits. Recommendations of the report include making climate change a foreign policy priority for all G7 members and using their clout to create a global resilience agenda.[48]

Dealing with the effects of climate change on business and the financial sector

While policies addressing overall conflict resilience and direct climate change related stress factors are often aimed at developing nations, the impacts of climate change on the financial world are of a different nature. These require economic and financial policies of all countries to converge in order to reduce the risk of climate change becoming a cause of severe stress to the global economic system as a whole.

Economic policies addressing the effects of climate change in particular involve shifting investments from fossil to non-fossil resources, for instance by using sovereign wealth funds and public pension funds, and rely upon the development of certain measures in the insurance sector, such as the development of improved statistics on climate risks and financial instruments needed to deal with them. Yet, many of the measures required to address climate change risks to the economic system have to arise from the private sector itself. Such voluntary private sector initiatives can include private equity

46 USAID (2015) Climate Change and Conflict – An Annex to the USAID Climate-Resilient Development Framework, Technical Report, February 2015.

47 Vivekananda, J., Janpeter Schilling & Dan Smith (2014) Climate resilience in fragile and conflict-affected societies: concepts and approaches. Development in Practice, Volume 24 2014 - Issue 4.

48 Rüttinger, 2015.

funds no longer investing in fossil fuels, or re-insurance companies forming working groups to address climate change risks. However, climate change impacts do not only impose new risks on the economic system, but may also provide large new opportunities – for instance for the insurance sector to invest in micro-insurance programs, climate-index-based insurance products for private and public sectors, as well as multi-country insurance risk pools.[49]

Preventing climate change policies from becoming a new source of conflict

Perhaps the most difficult challenge to policy in relation to climate change risk is to prevent policies intended to address climate change from causing unforeseen side-effects which can develop as new sources of conflict risks. Biofuel policies are the most prominent example of such well-intended policy initiatives producing unforeseen negative impacts by shifting land-use from food to biofuels production and thereby depriving parts of the population in some nations of essential food crops.

Future climate change policies could potentially introduce new dependencies on certain resources, thus impacting the relationships between countries or weakening regimes heavily dependent on fossil fuel rents. While the unforeseen side-effects of climate policies can never be fully prevented, a comprehensive geopolitical assessment of climate change policies targeting conflict factors could help minimize such 'collateral damage.'

The economics of building a framework for climate change conflict resilience

It is clear that economic policies are only one component of comprehensive climate change conflict resilience policies. In addition, the economic component of such policies is quite variable in character. It varies from taking into account unequal or changing distribution of wealth as a factor that can contribute to igniting conflict (for example via proper resource management arrangements between different groups affected by conflict) to economic policies and stimulation of voluntary business arrangements that can help stabilize the global economic sector and thereby prevent economic destabilization. It is also necessary to carefully design measures in such a way that unwanted side-effects, which could contribute to new conflicts in the future, are prevented as much as possible. Developing a quantitative policy framework for building climate change conflict resilience cannot, therefore, focus only on economic

49 EEA (2016) Climate change impacts and vulnerability, to be published.

components; rather, it should consist of several layers, of which economics is an integral part. Consider, for instance, the role of climate change as an impact factor on other societal aspects and the dependence of a country's economy on non-renewable energy. The aforementioned discussion of developing economic resilience, climate change as a threat multiplier, conflict induced by both identity related issues and distributional issues, coupled with the risks of an economy's reliance on non-renewable energy, when taken together, illustrate the dynamic relationship and interconnectivity of the economics of planetary security. For example, one particular economic aspect taken into account in the quantitative framework is that vulnerability to conflict can to a certain extent be compensated by economic resilience. A high GDP and low external debt, as well as a diverse economy and a well-developed market with high labour mobility, are factors that can help to counteract such vulnerabilities to conflict. Another crucial aspect which states need to consider is the diversification and complexity of a domestic economy. The more varied and manifold an economy is the more options both businesses and government administrations have to improve it. This ties in well to the need for high credit ratings as this takes into account the likelihood that such investments will reap high returns in the long and short term.

4 A Quantitative Framework for Climate Change Conflict

Introduction

This chapter introduces an experimental quantitative framework for analyzing the economic vulnerabilities and resilience of countries to climate change induced conflict. It is the first monitor to specifically divide the climate change and planetary security framework into four areas of discussion. It will be expanded and improved upon in the coming years.

The quantitative analytical framework of Economics of Planetary Security that is outlined here is based on the qualitative discussion in previous chapters and is therefore divided in four layers. The first three layers comprise of different indices which illustrate the degree of Conflict Vulnerability, Climate Change Vulnerability, and Low Carbon Risks. These layers, taken together, indicate the level of vulnerability a country faces. The last layer contains a resilience layer which focuses on how both public and private sectors can mobilize resources in developing economic resilience.

The multi-layered framework underscores that risks from climate change are not solely 'externally generated circumstances' to which a state responds, but are rather the result of complex interactions among the population, environment and economy. The overall quantitative framework results in a visual representation of resilience of countries to climate change as a conflict factor: the Climate Change Economic Resilience Monitor.

Layers of the framework

Previous climate change vulnerability monitors – such as the DARA Climate Vulnerability Monitor – focus on providing broader indices of climate change vulnerability.[50]
In digressing from this mainstream approach, the multi-layered structure of our quantitative framework allows us to create indices with specific focuses on certain areas of climate change. The four different layers allow for a thorough examination of the risks posed by climate change, and whether there is a heightened risk of climate change contributing to the onset of (violent) conflict. The first two layers aim to take into

50 "Climate Vulnerability Monitor - 2nd Edition - 2012 - CVF DARA," 2015, accessed July 11, 2016, http://www.thecvf.org/web/publications-data/climate-vulnerability-monitor/2012-monitor/.

account the breadth of different factors and comprise of more factors when compared to Layers Three and Four. Additionally, Layers One to Three taken together represent 'vulnerability' factors, whereas Layer Four represents 'resilience', here interpreted as the inverse of vulnerability.

Layer One, the Conflict Vulnerability Monitor, consists of the already existing HCSS Drivers of Vulnerability Monitor an interactive tool that allows users to assess intra-state fragility for around 200 countries worldwide on the basis of a vast indicator dataset that measures societal, political and security drivers of state.[51] Layer Two analyzes a state's vulnerability to the effects of climate change, or the degree to which a country's environment is exposed to the harms of climate change by factoring in environmental, hydrologic, geographic and topographic (land surface) concerns. Layer Three emphasizes the risk associated with transitioning to a low carbon economy. Layer Four analyses the economic capacity of states to resist or mitigate (resilience) the negative impacts of climate change in order to reach and maintain a certain level of functioning, and it is described as the Climate Change Economic Resilience Monitor:

1. Layer One: Conflict Vulnerability Monitor
2. Layer Two: Climate Change Vulnerability Monitor
3. Layer Three: Low Carbon Risk Factors Monitor
4. Layer Four: Economic Resilience Monitor[52]

For a more concise overview of the indicators used in the different layers and how the data was computed, please read the Annex on the indicators used in each layer (Annex 1 – 4) and the methodology (Annex 6).

51 HCSS, *Drivers of Vulnerability Monitor,* (The Hague: HCSS, n.d.).

52 Due to the lack of data on the business and financial sector at a country level – as opposed to an organizational level – it proved to be difficult to include these components into the monitor. Instead, this report introduces a layer on Economic Resilience.

Indicators in the Conflict Vulnerability Monitor

Table 2 Indicators and Subdomains in the Conflict Vulnerability Layer. See Annex 1 for more detail.

Layer One: Conflict Vulnerability Monitor		
Security Subdomain	**Political Subdomain**	**Socio-Demographic Subdomain**
Maximum Conflict Intensity	Polity 4 Score	Infant Mortality
Best Estimate from Death Toll	Variance in Polity4 Score	Life Expectancy at Birth
Global Terrorism Index	Factionalism Dummy	Human Development Index
Political Terror Scale	Rule of Law	Ethnic Fractionalization
Refugees Produced	Control of Corruption	Female Labor Participation

The Conflict Vulnerability Monitor measures the (in)ability of a country to withstand societal, political and security pressures. Conflict vulnerability – in this context – refers to the degree to which a country's population is exposed to conflict and is susceptible to the emergence thereof as a consequence of, *inter alia*, bad governance, low quality of life, no adequate rule of law and various other factors. Taken together, these different characteristics influence the degree to which a country is able to successfully withstand internal and external socio-political stressors.[53]

Social vulnerabilities at an individual level are largely absent from the indicators used, mainly due to the difficulty in measuring and quantifying the indicators involved; rather, the monitor focuses on levels of social cohesion and development. In the final monitor, users can generate their own composite indices which can in turn be exported in various forms. This added value of utility makes it a powerful research tool.

Drawing inspiration from the HCSS Drivers of Vulnerability Monitor, the analysis in level one is divided into three subdomains: social, political and security.[54] It is evident that there is a degree of overlap between these indicators and those used in the other domains (see Annex for the indicator criteria selection). The security subdomain addresses issues such as incidence of conflict, terrorism and mortality. Worthy of note is the lack of attention granted to solely state and non-state actors through the creation of smaller domains. The added value of grouping these two types of actors is that it grants a holistic awareness of the overall status of security in a country. It is possible, however,

53 "IPCC Third Assessment Report - Climate Change 2001," accessed July, 2016, http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/wg2/689.htm.

54 HCSS, *Drivers of Vulnerability Monitor*, (The Hague: HCSS, n.d.).

in a latter iteration that further divides the security subdomain based on the type of actor. The political subdomain zooms in on a country's political context with an emphasis on political variance, rule of law, prevalence of corruption and the quality of governance. The social subdomain addresses the development, demographic and health aspects of vulnerability (see Annex 1).

Indicators in the Climate Change Vulnerability Monitor

Table 3 Indicators and Subdomains in the Climate Change Vulnerability Layer. See Annex 2 for more detail.

Layer Two: Climate Change Vulnerability				
Precipitation Subdomain	**Sea Subdomain**	**Water Subdomain**	**Land Subdomain**	**Disasters Subdomain**
Changes in Average Precipitation- *Coefficient of Variation*	Population Living Below Five Metres Above Sea-Level	Water Stress	Percentage of Desert of a Country	Vulnerability to Weather-related Disasters (Drought, Floods, Storms & Extreme Temperatures)
Changes in Average Precipitation- *Difference in Absolute Values*		Renewable Internal Freshwater Resources Per Capita	Arable Land	

The second layer focuses solely on environmental factors and their relationship with climate change. Vulnerability encompasses a variety of concepts which include sensitivity or susceptibility to harm, and conventionally, the lack of capacity to adapt.[55] Climate change vulnerability is the degree to which a country's environment is exposed to the harms of climate change by factoring in environmental, hydrological, geographic and topographic (land surface) concerns.

Economic and social vulnerabilities were excluded from the indicators as they were deemed irrelevant in the conceptualization of climate change vulnerability; rather, with an emphasis on the environment, it attempts to reduce the amount of data with human-related aspects. In the final monitor users too will be able to generate their own

55 Oppenheimer, M., et. al, 2014: Emergent risks and key vulnerabilities. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the*

composite indicator, thus having the option of removing human-related data sets such as water stress and populations living in areas below five meters above sea-level.

The topic areas are divided into five subdomains: land, water, disasters, precipitation and sea-level. These five domains were selected as they best captured a holistic understanding of the environment. The land domain relates to agricultural issues by focusing on arable land and desert, the water domain relates to domestic freshwater sources and water stress, the precipitation domain best captures atmospheric conditions and change over time, while the sea-level domain focuses on rises in sea-level. The disaster domain focuses on extreme scenarios in a range of these subdomains. Taken together, these different characteristics influence the degree of harm climate change may have on a country by expressing a vulnerability score which could be reinterpreted as a sum of external environmental stress. The land subdomain addresses the nature of land degradation with indices such as arable land and percentage of desert of a state as a proxy of desertification. The precipitation subdomain uses the volatility of precipitation and the change overtime to determine the changing nature of precipitation, with the degree of change indicative of vulnerability. The disaster subdomain is a composite indicator which tallies the frequency of weather-related disasters (storms, floods etc.). The sea-level subdomain is its own indicator which conveys the percentage of a country's population living below 5 meters above sea-level. Lastly, the water subdomain focuses on the state of water bodies in a country and the degree to which they are vulnerable (see Annex 2).

Indicators in the Low Carbon Risk Factors Monitor

Table 4 Indicators in the Low Carbon Risk Factors Layer. See Annex 3 for more detail.

Low Carbon Risk Factors				
Rents from the Following Resources: Oil, Gas, Mineral, Forests and Coal	Electricity Production from Sources of Oil	Renewable Energy Consumption	Greenhouse Gas Emissions	Greenhouse Gas Emissions (change from 1990)

The third layer investigates the degree to which a country is dependent on fossil fuels and the risks associated with such a dependency for its economy. Risks here include the potential for consequences where the outcome is uncertain.[56] It is often represented as the probability of the occurrence of hazardous events and usually results from the

56 Ibid.

interaction of vulnerability and exposure to a particular hazard. While this layer has an economic taint to it, it is imperative to take into consideration that this risk is amplified once it is taken in relation to the previous layers.

In order to capture the dependency on fossil fuels, fossil fuel resource rents of the countries, the proportion of electricity produced from oil sources, and the degree of renewable energy consumption are used. Again, here it is more desirable to have a low score as this indicates a lower level of risk. With countries incrementally adopting or ratifying pro-climate change treaties, it is increasingly likely that states will transition to low carbon economies. Layer Three, therefore, illustrates the ease of such a transition. It was decided that dividing this layer into smaller sub-domains was undesirable as this layer is not as extensive and broad as Layer One and Layer Two, and aims to focus solely on a country's dependence on fossil fuels by integrating data from resource rents, renewable energy consumption and greenhouse gas emissions

Indicators in the Economic Resilience Monitor

Table 5 Indicators in the Economic Resilience Layer. See Annex 4 for more detail.

Economic Resilience Layer					
GDP per Capita, PPP	External Debt ($)	Economic Complexity Index	Credit Rating	Labour Force	Index of Economic Freedom

Climate change resilience, as a subfield of climate change impact, is a relatively novel area of investigation. In light of how the data was computed, it was decided that the final score of this layer would be taken in inverse form to allow us to create a consolidated aggregate of the four layers, and to make a high score less desirable here as well. Generating the inverse had no ramifications on the normalization techniques used. Layer Four provides a more specific understanding of economic resilience to climate change.

Layer Four focuses on economic indicators and how they illustrate the overall degree of economic resilience in a country. Economic resilience is defined as the economic capacity of a state susceptible to climate change effects to adapt, through resisting or changing, in order to maintain an acceptable level of functioning and structure.[57]

57 *Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1039-1099.

The ability of a country to deal with climate change depends on how vulnerable it is according to Layers One to Three and how it relates to the degree of economic resilience a country possesses.[58]

Unlike the first two layers, and similar to Layer Three, the Economic Resilience Layer is not divided into subdomains because of its already specific nature, as it purely targets economic indicators. The indicators aim to highlight economic resilience from both a public and private point of view, in order to give policymakers and businesses professionals an understanding of what needs to be addressed, or invested in, respectively. Economic resilience is often equated to development intervention, and/or business activism. In creating two subdomains, such as a private subdomain and public subdomain, one risks isolating the variables from one another, subsequently painting a less comprehensive picture and showing little overlap between the two respective sectors. The advantage of this is that it shows the most desirable configurations/ scenarios that governments should have in combatting climate change (see Annex 4).

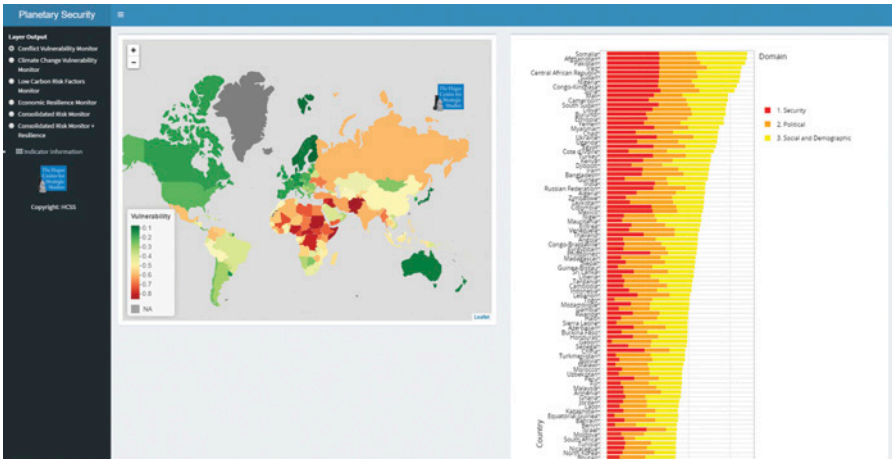
Consolidated Layers

The Consolidated Layers aim to provide readers with an aggregate value of the combination of the layers. These aggregates aim to capture the conversation of the Economic of Planetary Security, by aggregating the scores of the different layers together. There are two possible combinations: The first combination is a Consolidated Risk Layer. The aggregate output from this layer aims to capture the overall level of risk a state is in. This Consolidated Risk Layer factors in Layers One to Three. Countries which score highest in this layer are countries which have high scores across the board in the first three layers. The second combination combines the previous layer as an aggregate score with the degree of economic resilience, culminating in the Consolidated Resilience Layer. For policymakers, this indicates the overall degree of resilience to climate change and the countries which are most capable of mitigating the negative impacts of the four different layers. The importance of this layer to both policymakers and business professionals should not be understated. Firstly, it grants them further insight into how the whole is greater than the sum of its parts, how these three layers taken together illustrate the overall state of preparedness in a country. Secondly, it can help policy makers forecast future trends in regards to the multiplier effects of climate change by cross comparing the consolidated layers with the first four layers.

58 "What Is Disaster Resilience?," Humanitarian Issues, June 2015, accessed August 31, 2016, http://www.gsdrc.org/topic-guides/disaster-resilience/concepts/what-is-disaster-resilience/.

5 Results of the Framework

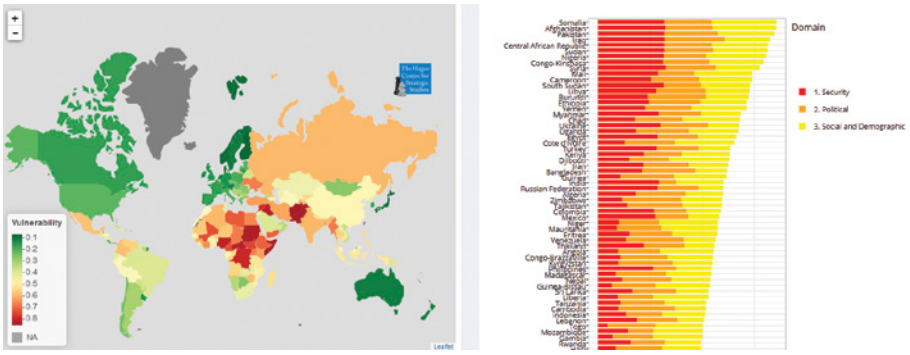
Figure 6 An image of the Monitor in its online form



The different layers, both individually and when taken as an aggregate, result in a visual representation of resilience to climate change as a conflict factor (see §2.3) and the varying degrees of risk involved. The legend of the monitor is divided into three different colors: green, yellow and red. The greener a country is, the lower their score. To policymakers and business professionals alike, it is expected that obtaining a greener shade is more desirable as this represents a greater degree of wellbeing. The more red a country is, the higher their score. Red is therefore an undesirable color, as this illustrates high vulnerability, high risk and low resilience. Yellow implies that a country is in the medium range. It is advisable to the reader to go through the subsequent text while looking at the monitor.

Layer One: Conflict Vulnerability Analysis

Figure 7 An overview of the general outcomes of Layer One in the monitor



Looking at the monitor it becomes apparent that most of the Global North is less vulnerable to conflict in comparison to the Global South. At face value, it seems that the most vulnerable countries are centered in the Middle East and Africa – this is arguably due to the fact that these regions suffer from ongoing conflicts. The majority of these conflicts are not interstate, but rather between insurgent non-state actors against the state or among themselves. Indeed, the changing nature of international warfare as previously outlined in paragraph 2.1, has been characterized by this rise in non-state insurgencies, and this is particularly pertinent to the results of these datasets.

Overall, much of the African continent ranges in the Medium to high vulnerability range, with Namibia and Botswana as the only outliers with low conflict vulnerability. This is in stark contrast with Sub-Saharan Africa, and the Sahel regions, which score high on conflict vulnerability range. Europe – and Scandinavian countries in particular – have low scores on the vulnerability range, having no recent or current conflict recorded. A similar situation can be seen in North America, where the USA and Canada, followed by Panama, score low on the vulnerability range, while Caribbean states range in the medium vulnerability area. Latin American countries, save for Columbia and Venezuela, display low vulnerability. Mongolia, Australia and Japan, also score quite low, making them regional outliers in Asia and Oceania.

Top Ten: Countries ranked most vulnerable

Table 6 The most vulnerable countries in Layer One

Rank	Country	Overall Score
1	Somalia	0.851
2	Afghanistan	0.850
3	Pakistan	0.843
4	Sudan	0.834
5	Iraq	0.822
6	Central Africa Republic	0.815
7	Nigeria	0.805
8	Congo DR	0.793
9	Syrian Arab Republic	0.776
10	South Sudan	0.752

The top ten most vulnerable countries are predominantly located in the MENA region. All of these countries are experiencing some form of insurgency or internal conflict. The degree of vulnerability along the top ten increases gradually, with Somalia having a 0.001 increase to Afghanistan, and having approximately a 0.01 increase to South Sudan, indicating that the degree of vulnerability across the top does not vary too much.

Considering that some of this data is taken from 2014, Iraq and Syria are expected to score more highly in future monitors with the rise of ISIL, Kurdish insurgencies and other militias within their borders. Additionally, most of these countries score highly in the security sub-domain, meaning that when normalizing the data across the three sub-domains, much of the data produced here is considerably higher than that in the other sub-domains (political and socio-demographic). This means that they are more unstable. Potentially, as a result of the regional climate and its geopolitical importance, Turkey will score higher in the security sub-domain in the near future due to its recent increase in domestic conflict.

Bottom Ten: Countries ranked least vulnerable

Table 7 The least vulnerable countries in Layer One

Rank	Country	Overall Score
1	Finland	0.073
2	Denmark	0.085
3	Norway	0.087
4	Japan	0.095
5	Netherlands	0.103
6	Sweden	0.106
7	Australia	0.109
8	Slovenia	0.115
9	New Zealand	0.118
10	Austria	0.121

The lack of conflict in Europe, most notably in Northern Europe – with all Scandinavian countries represented in the bottom ten overall (occupying the top three positions in Table 7) – is one of the main reasons that the least vulnerable countries are Euro-centric, with the exceptions of Japan, Australia and New Zealand. The variance across the bottom ten highlights that there is not much difference in the degree of vulnerability across these datasets. Considering that most of these countries are lauded for their high quality of life[59] – namely Denmark, the Netherlands and Austria – and for their respective welfare systems in place, the extremely low scores in the socio-demographic subdomain and the political subdomain (see annex) might explain their low overall scores.

Consideration One – Conflict Intensity in the MENA Region

From the data set, there is an evident correlation between countries who score highest in the Layer One Security subdomain, and those who score highest overall. The security sub-domain consists of indicators that include: maximum conflict intensity, the global terrorism index, political terror scale, refugees produced and best estimate from state based violence (see Annex 1). Consequently, it is unsurprising to find that conflict zones score the highest in this subdomain, with several MENA countries occurring in the top 20. This is indicative of the overall impact of conflict intensity in the MENA region. With many MENA governments playing an active role in quelling domestic insurgent groups, in particular the Syrian and Iraqi governments, it calls into question how conflict vulnerability can be mitigated from a policy viewpoint, especially when considering if a central government's grip on power is dwindling. This paints a bleak picture especially

59 Refer to annex and our statistics.

when factoring in conflict intensity in the MENA Region with the potential multiplier effects of climate change, with this potentially giving impetus to conflict with fighting over scarce resources (see §2.3).

One of the many tensions that contributed to the Arab Spring were food shortages across the MENA region, particularly in Tunisia.[60] The political context in Syria reflected that of Tunisia, as did Egypt.[61] With these areas becoming increasingly arid and expected to experience even less precipitation due to climate change, the intensity of conflict should be cause for concern, especially considering for example Syria's low score in the Layer Two precipitation sub-domain (which here can be conceptualized as low precipitation and more dryness) and high score in the Layer Two land sub-domain. Moreover, few countries in the MENA region have the funds to combat and mitigate the impact of conflict, as well as environmental stress.[62] An example is Yemen, which is currently hosting an unprecedented insurgency between the Shia and Sunni factions, experiences high levels of water stress, and ranks sixteenth overall in Layer One.[63] If the environmental situation worsens, the level of conflict intensity is likely to increase (see §2.2). Considering Yemen's high score in Layer One, and its medium to high score in Layer Two, coupled with its weak level of Economic Resilience, our monitor illustrates the overall vulnerability of the Yemeni state and it's dire need for a broad agenda in combating climate change.[64]

Consideration Two – Government Effectiveness in Sub-Saharan Africa

Most African countries score high in the Layer One political sub-domain (see online Monitor). Much of this is attributed to the volatile nature of politics in Africa, where regime change, post-colonial political tensions and coup d'états (successful or unsuccessful) have significant impacts on the overall degree of conflict vulnerability on the continent. Stability, which is equated here with low/no vulnerability, is difficult to achieve in African politics due to the lack of social cohesion among the population

60 "Syria: Climate Change, Drought and Social Unrest," the Center for Climate and Security, February 29, 2012, accessed January 20, 2016, https://climateandsecurity.org/2012/02/29/syria-climate-change-drought-and-social-unrest/https://climateandsecurity.org/2012/02/29/syria-climate-change-drought-and-social-unrest/.

61 Ibid.

62 Ibid.

63 "A Storm Without Rain: Yemen, Water, Climate Change, and Conflict," the Center for Climate and Security, August 3, 2016, accessed September 1, 2016, https://climateandsecurity.org/2016/08/03/a-storm-without-rain-yemen-water-climate-change-and-conflict/.

64 Ibid.

barring different ethnicities and subsequently, different factions.[65] As a result of regime change, which is calculated in the Polity4Score and the Political Variance, lack of social cohesion can be identified quite frequently.[66] Some countries experience very few changes, and have (statistically) low/no variance. An example of this would be Russia and China, with the latter having no variance owing to the dominance of the communist party, illustrating that undemocratic states could perform quite well in the political sub-domain.

Looking at Layer One, it is evident that Sub-Saharan Africa is vulnerable to conflict, and is most predominantly vulnerable in the political sub-domain (Layer One). Taken in relation with other layers, this could prove problematic considering the conversation of economics of planetary security.[67] It is evident from the consolidated resilience monitor that Sub-Saharan countries fare worse. Most countries in Sub-Saharan Africa have received funding from the World Bank and the International Monetary Fund, in the form of sectoral adjustment programs and through the Comprehensive Development Framework, owing to their lack of domestic mechanisms to generate revenue. With many local actors competing for influence in order to promote particularistic agendas, a portion of the population will always have their interests ignored, and this will likely continue to be the case due to the lack of democratic mediums in these countries. Therefore, from a political perspective, the lack of social cohesion is one of the main motivators of conflict.[68]

It is evident that in Sub-Saharan Africa, countries (and especially land locked countries) are less prone to conflict deriving from environmental stress, as much of the region scores low or medium in the Climate Change Vulnerability Layer. This is not to discount the possibility of environmental stress induced conflict but merely to articulate to policy makers where the emphasis in a broad agenda should be. The priority of countries should be to implement a stable platform upon which policies can be implemented. This implies that conflict is more likely to emanate from ethnic and political difference which may cause a mismanagement of resources, as opposed to being motivated directly from the climate (see §2.2). Essentially, environmental stress, if properly managed through more effective governments, can be mitigated as a threat multiplier (see §4.1-4.6).

65 "Assessing Climate Security Vulnerability in Africa: CCAPS's New Online Dashboard," the Center for Climate and Security, September 10, 2013, accessed September 2, 2016, https://climateandsecurity.org/2013/09/10/assessing-climate-security-vulnerability-in-africa-ccapss-new-online-dashboard/.

66 D. N. Posner, "Regime Change and Ethnic Cleavages in Africa," *Comparative Political Studies* 40, no. 11 (September 17, 2007), doi:10.1177/0010414006291832.

67 Cornelia F. A. van Wesenbeeck, Ben G. J. S. Sonneveld, and Roelf L. Voortman, "Localization and Characterization of Populations Vulnerable to Climate Change: Two Case Studies in Sub-Saharan Africa," *Applied Geography* 66 (January 2016), doi:10.1016/j.apgeog.2015.11.001.

68 Ibid.

Case Study Somalia

Figure 8 Somalia (UNDFS, 2011)

Somalia offers an interesting case as it scores highly in conflict vulnerability, climate change vulnerability and economic resilience but is the country with the lowest carbon risk. Somalia is ranked highest in Layer One, ranked tenth in Layer Two, and ranked second in Layer Three, but ranked last (lowest) in Layer Four. In Layer One, this is not entirely surprising considering it has one of the top three scores in two of the sub-domains (security and political). In Layer Two, much of Somalia's climate change vulnerability stems from its low levels of precipitation and its large composition of desert. Much of the conflict in Somalia has been inspired by ethnic conflict and disagreements between the Islamists and the federal government in Mogadishu.[69] If climate change were to act as a multiplier threat this may prove to be a cause for concern as much of the conflict has been fought on political and ethnic lines. If resources and water were to continue to be in low supply, future conflicts may be fought over physical resource scarcity. With Somalia being one of the highest refugee

69 *Somalia National Adaptation Programme of Action to Climate Change*, (United Nations Development Programme, 2013), http://unfccc.int/resource/docs/napa/som01.pdf.

producing nations, coupled with the lack of conflict on resources in the region (at least as a prime instigator), future causes of conflict may be more complex than contemporary ones.

Moreover, with the lack of a formal market and economy on the whole, Somalia scores quite high in economic resilience. Admittedly, there is missing data on Somalian debt, credit rating and economic freedom. This amounts to low – if any – economic resilience to climate change conflict; however, due to the lack of a formal market, Somalia subsequently has the lowest carbon risk.

The interplay with the four different layers presents Somalia as a conundrum to policymakers. With the lack of a strong domestic core of government and government actors, whether or not the Somalian Federal Government can implement change is cause for concern. Furthermore, with Somalia already highly vulnerable to conflict, increases in environmental stress can have severe implications on its population, as it is more prone to violence or escalation of existing tensions (see §2.3). In mitigating both conflicts induced by political, social and security factors, and by climate change, the present government does not have the means to do so successfully.

Layer Two: Climate Change Vulnerability Analysis

Figure 9 An overview of the general outcomes of Layer Two in the monitor

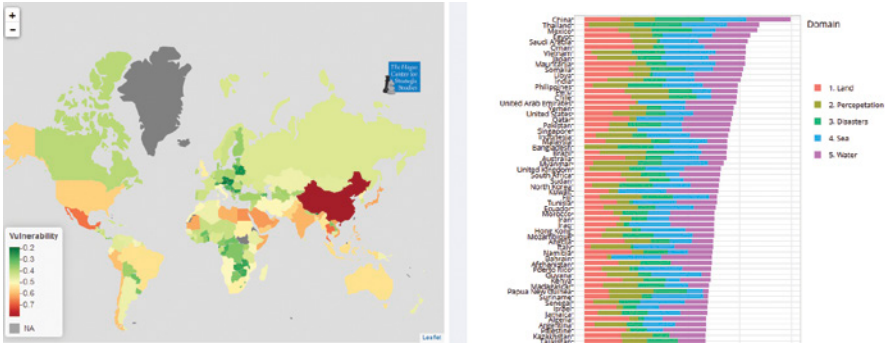


Figure 1 shows that there are more regional variations in Layer Two in comparison to Layer One. One remarkable feature of Layer Two is how well landlocked countries perform. Overall, landlocked countries in Asia, Africa, Europe and South America all score quite low, with Kyrgyzstan, Tajikistan, Austria, Switzerland, Rwanda, Zambia, Bolivia and Paraguay producing low scores in their respective continents. Africa, on the whole, seems to performing quite well with several countries in the high vulnerability

range. Those which perform worse are often countries in the Sahel region or in the Horn of Africa – due to the lack of precipitation and expansiveness of deserts in the area. European countries all range in the very low to medium areas, with the exception of Italy and the United Kingdom and Northern Ireland.

Asia contains the most diverse range of scores with northern Asian states scoring low, and with Southern Asia scoring high, especially China and Thailand. North America region varies too, with the USA and Mexico being the most vulnerable states. The USA – owing to its geographic location and physical endowment – is vulnerable to a wide variety of different indicators in Layer Two. South America mirrors Asia's diversity with Chile and Brazil scoring the highest in those areas, notably due to Chile's Atacama Desert and water stress, and Brazil's volatile precipitation.

Top Ten: Countries ranked most vulnerable

Table 8 The most vulnerable countries in Layer Two

Rank	Country	Score
1	China	0.796
2	Thailand	0.676
3	Mexico	0.669
4	Egypt	0.64
5	Saudi Ara	0.632
6	Oman	0.622
7	Vietnam	0.622
8	Japan	0.621
9	Mauritania	0.619
10	Somalia	0.614

From the top ten it is evident that China is by far the most vulnerable country in Layer Two, with a 0.12 increase over Thailand. China is ranked highly mainly due to their demography, diverse geography and topography, allowing them to score high in a range of indicators, especially in the water, sea-level and disaster domains. To that end, considering that the disaster domain largely depends on the number of individuals impacted by disasters and that China has the largest population in the world, especially in the South East of the state, it is not surprising it performs poorly in this layer.

From the data it is evident that most of these countries are either vulnerable due to their location in the tropics and the subsequent effects of precipitation, location of their main demographic, vulnerability to disasters, or cover large swathes of desert. For instance, Oman, Somalia, Saudi Arabia and Egypt, score highly in the land domain. Egypt and Vietnam occur in the top ten mainly due to the former's size of desert and arable land

coupled with the number of people living below 5 meters above sea-level, and the latter's similarly low lying populations.

Bottom Ten: Countries ranked least vulnerable

Table 9 The least vulnerable countries in Layer Two

Rank	Country	Score
1	Rwanda	0.192
2	Slovakia	0.2
3	Luxemborg	0.201
4	Austria	0.212
5	Bhutan	0.234
6	Czech Rep	0.239
7	Hungary	0.245
8	Belarus	0.248
9	Mauritius	0.253
10	Bulgaria	0.269

A distinct trend from the bottom ten – the least vulnerable countries – in Layer Two is the fact that all these countries are land locked (with the exception of Bulgaria and Mauritius) and that they are relatively flat or small countries. Bearing in mind the conceptualization of the variables as outlined in §5.4, the fact that they are land-locked has two important implications: it usually means that most of the population lives above the 5 meters sea-level threshold, and that they are less likely to endure other coastal disasters or threats. For instance, eight out of the ten countries score zero in the sea sub-domain, implying that small numbers of the population live below sea-level, or none at all (this depending on the normalization of the data). Seven out of the ten countries are European, which may be a result of the widely accessible arable land in central Europe.

The variation among the top four is not too high, with the scoring being relatively close. Rwanda is an exceptional case, mostly owing to its low scoring in the land, disaster and sea sub-domains. This highlights that there is low environmental stress in the country.

Consideration Three – Disaster Related Risks and the Ensuing Instability

Table 10 The top ten countries in the disaster subdomain

Rank	Country
1	China
2	Thailand
3	Guatemala
4	Bolivia
5	Mexico
6	Bangladesh
7	Somalia
8	Paraguay
9	Pakistan
10	Philippines

Disasters can have enormous ramifications on the well-being of a state. As stated earlier, disasters can result in the destruction of infrastructure (see §3.1), facilities and homes, and consequently disrupt social and economic developments, halt financial markets and may lead to many casualties among a country's population. This is mainly why the discourse on climate change as a threat multiplier has become increasingly important in today's world, and why taking the different indicators together offers new insight into the potential instability which might come with climate change. Most of the countries in the top ten disaster domain are countries that already endure various social, economic and political challenges and are relatively vulnerable to climate change in general. The impact of disasters in these areas can therefore catalyze conflict vulnerability, especially in Pakistan and Somalia, where little domestic infrastructure is present to counter these climate change induced disasters.[70]

Linking disaster related risks to conflict vulnerability has not been systematically done in previous climate change literature; however, this list of countries further inspires this link, considering that many of these countries either have a high population or densely populated urban areas. In the case that these areas are hit by disasters, the subsequent social upheaval could render much of the population more vulnerable to conflict and instill popular discontent with the status quo.[71] In the long term, in times of desperation, as in Somalia and Pakistan, extremist groups can exploit the new status quo by recruiting victims of these disasters with the promise of supplying them basic

70 Ibid.

71 Katie Harris, David Keen, and Tom Mitchell, *When Disasters and Conflicts Collide*, (London: UK Aid, 2013), https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8228.pdf.

essentials. This can present political opportunities for not only engaging in more conflict, but disasters can act as scapegoats for political motivations and objectives, such as increasing military expenditure, relocating troops to sensitive areas, or by redirecting aid for self-enrichment.[72]

This relationship illustrates the importance of creating an integrated approach to combating climate change, and in this case, disasters caused by climate change.[73] Fortunately, with the exception of Somalia and Pakistan, most of these countries score in the medium range in the Conflict Vulnerability Layer. There are only a few cases where disasters have, indeed, assisted peacebuilding, resulting in some resolutions of conflicts. Conflict vulnerability is also compounded by the occurrence of natural disasters, the misappropriation of aid, and/or the asymmetry that disasters may cause by impacting insurgencies differently. Conflict increases disaster risk by displacing individuals into areas which can be deemed more vulnerable to conflict. Another related disaster risk is the impact of disasters on the economy. In case a country is continuously challenged by disasters, its infrastructure will be undermined perpetually or will be in continual need of being repaired. The economic costs to do so requires development of economic resilience. The above discussion on the impact of conflict coupled with the impact of disasters highlights the importance of having a strong economic resilience agenda to help improve links between social and economic development, while bearing in mind the implications of the environment (see §4.3 & 4.5).

Consideration Four – Scarcity of Land and Water Implications

The effects of arable land and water scarcity – as part of the land and precipitation sub-domains – can have severe implications on the well-being of a country (see §2.2). There is a large backlog of historical water conflicts extending back thousands of years. The Pacific Institute has documented (approximately) every water conflict since 3500 BCE.[74] Taking Layer One and Layer Two's sub-domains of land and water, one can see that there are inherent risks that may result in water-related violence and conflict, as populations place pressure on scarce water resources. Many of these risks are materializing at the domestic level, between domestic actors, and at an international level – as proven with the recent River Nile water dispute. But some argue that the Arab Spring and the more recent upheavals in the Middle East are inspired by water scarcity.[75] As freshwater is vital, but is often unevenly distributed in the MENA region,

72 Ibid.

73 Ibid.

74 "Water and Conflict - Pacific Institute," Pacific Institute, 2016, accessed November 9, 2016, http://pacinst.org/issues/water-and-conflict/.

75 "Huffington Post: Water and Conflict in Syria - Pacific Institute," Pacific Institute, May 28, 2014, accessed September 2, 2016, http://pacinst.org/water-and-conflict-in-syria/.

its availability greatly impacts the quality of life of a country. In addition, creating a cost-effective water supply system is difficult to implement, more so when a country is engulfed in war.

Table 11 The most vulnerable countries in the Water subdomain and Layer Two

Rank	Country	Water
1	Kuwait	0,984
2	United Arab Emirates	0,969
3	Bahrain	0,965
4	Saudi Arabia	0,962
5	Yemen	0,947
6	Pakistan	0,936
7	Qatar	0,935
8	Israel	0,931
9	Singapore	0,913
10	Jordan	0,906

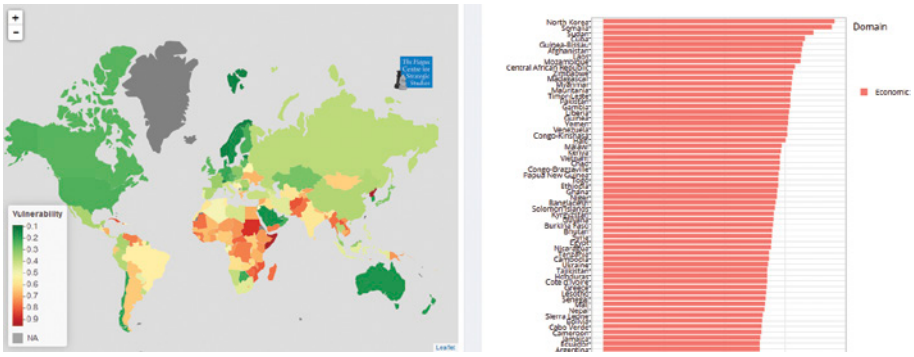
Out of the top ten countries with the highest water vulnerability, only two are located out of the Middle East, with Singapore and Pakistan ranked ninth and sixth respectively. It is often difficult to establish a direct relationship between climate change and armed conflict, however given the uncertainty in the region, and the lack of access to water and lack of domestic bodies of water, it is expected that water scarcity will act as a catalyst to further conflict and could lead to disruption of local businesses (see §2.2 & §3.1). It could also undermine the future long term economic resilience of a country to climate change. Lack of water coupled with conflict may lead to mass migration of the inhabitants of one country to another.[76] Alternatively, countries with a mismatch in water management may impact water reliant sectors, causing social unrest and tension in already vulnerable countries, potentially leading to higher market prices; however, the research into the migration-environment relationship is still nascent, meaning that further investigation into this field is needed.[77]

76 Lori Hunter, "Migration and the Environment," in *International Handbooks of Population*, ed. Raphael Nawrotski, by Dudley L. Poston, Jr. (London: Springer, 2015).

77 Ibid.

Layer Three: Carbon Risk Analysis

Figure 10 An overview of the general outcomes of Layer Three in the monitor



The overall pessimistic scores in Layer Three – especially in comparison to other layers – are unsurprising considering how non-renewable energy is still widely used and remains the major source of energy for many states (see §4.5). Figure 10 shows a global trend in dependency on the export of fossil fuels. An interesting caveat, however, is that most war torn countries such as Afghanistan, Somalia, Iraq and Pakistan seem to be faring relatively well, mostly in the low-risk to medium-risk range. Except for a few small enclaves in North America (such as Panama) and South America (such as Paraguay and French Guyana), the overall level of carbon risk is medium to high risk. Africa and Europe have the most optimistic scores of carbon risk. In the former, the Horn of Africa surprisingly has the best regional performance of any region around the world. In contrast, Northern Africa, with their reliance on oil exports, scores in the high risk range. This trend continues across the Sahara and into the Najd region, with Saudi Arabia and Yemen having high-risk scores.

In Europe, the reliance on carbon energy in Ukraine (gas) and Poland (coal) is evident, as they act as the only outliers in the overall European trend. The United Kingdom, Norway and Germany are at medium risk, but this should not be problematic considering they each possess a high level of economic resilience (as explained in Layer Four), meaning their transition into a low carbon economy may be smoother than anticipated and may already have policies in place to do so. In general, however, Asia performs quite poorly. Many of the larger countries such as Kazakhstan, Russia, Mongolia, India and China score high with carbon risk. Regionally, South East Asia seems to buck this trend, but still performs poorly considering most countries score in the medium risk range.

Top Ten: Countries with the highest carbon risk

Table 12 The countries with the most carbon risk in Layer Three

Rank	Country	Score
1	Botswana	0.746
2	Iran	0.739
3	Yemen	0.711
4	Kazakhstan	0.697
5	Russia	0.688
6	Australia	0.666
7	Saudi Arabia	0.652
8	Bolivia	0.651
9	Mongolia	0.647
10	Laos	0.645

The variation among top ten countries does not seem to be too extreme; however, Botswana and Iran seem to be considerably ahead of third placed Yemen, with an increase of 0.03 and 0.02 carbon risk respectively. It is relatively surprising for Botswana to have the highest score in carbon risk, especially considering how well it performed in the other three layers, having very desirable scores in all the layers. This suggests that a high carbon risk score may not be entirely problematic should the country seek to transition into a low carbon economy. For policy makers, this may present itself as an opportunity in helping a less economically developed country transition to more renewable energy with a continental backdrop like Africa.

With the exceptions of Botswana, Australia and Bolivia, there is a strong Asian representation here. The appearance of Russia and Saudi Arabia is partly due to their respective export of natural gas and oil, with both nations heavily dependent on these export industries. These two nations may experience severe difficulties in their transition towards a low carbon economy due to their historical reliance on these industries, the vast reserves and physical endowment of these countries based on these energies, and the change of business culture associated with these industries. Additionally, developing countries may have greater opportunities to design their economy on a low carbon risk base. Yemen, however, may experience difficulties in such a transition due to the current ongoing conflict, the lack of natural resources and its relative isolation from (international) financial investments.

Bottom Ten: countries with the lowest carbon risk

Table 13 The countries with the least carbon risk in Layer Three

Rank	Country	Score
1	Somalia	0.201
2	Afghanistan	0.219
3	Switzerland	0.239
4	Moldova	0.258
5	Paraguay	0.259
6	Uganda	0.264
7	Latvia	0.266
8	Comoros	0.284
9	Slovenia	0.297
10	France	0.300

The appearance of Somalia and Afghanistan paints a less grim overall picture of the two nations considering their high scores in other layers. Their appearance here can be attributed to the lack of domestic infrastructure geared towards producing and harnessing non-renewable energy or their low producing formal economies. This pitfall can be linked to how conflict has mitigated any form of economic development, which is *per se* undermined by the overall lack of funds in their respective economies. This illustrates the intimate relationship between non-renewable energy, development and economic resilience, as many developing nations equate using non-renewable energy as a key ingredient in developing their economic resilience. Moreover, there is a lack of regional dominance in the bottom ten, which is indicative of the global diversity when it comes to energy (or the lack thereof).

Consideration Five – Implications of Carbon on Economic Resilience

Transitioning to a low carbon economy is both an opportunity and a challenge to policymakers and the private sector alike. An integral facet of low-carbon solutions is the manner in which they are commercialized, as this can help catalyze emerging markets and support the diversification of the international energy sector. An obstacle in the effectiveness and wide-reaching acceptance of climate change policy is the lack of alignment between various climate change policies and transitioning towards low-carbon economies, with this misalignment often unidentified or left unaddressed.[78] The implications of this on economic resilience is great, as economic resilience

78 Alexander van Tilburg et al., *Paving the Way for Low Carbon Development Strategies*, (n.p.: Energy research Centre of the Netherlands, 2011).

can be geared on the basis of both enhancing the economic capability to mitigate environmental stress and the multiplier threats from which it is derived.

For policy makers there seems an eternal paradox between the need for rapid response and urgent action towards climate change effects, and the fear of higher costs involved in a transition to a low carbon economy (resulting in slow economic development). If anything, the relationship between Layer Three and Layer Four indicates that these need not be mutually exclusive. This, however, should present itself as an investment opportunity to businesses to commercialize low-carbon solutions. Take, for instance, the case of Botswana, which has low conflict vulnerability, relatively low climate change vulnerability, strong economic resilience and high carbon risk. Nevertheless several issues need to be balanced out to ensure that stability and social well-being will be maintained.[79] While transitioning to a low-carbon economy would mean that Botswana is deprived of its main source of income – as it is evidently dependent on fossil fuel rents – there is a lack of domestic instability and conflict potential. Botswana, as an African case, can integrate these elements together and should aspire to diversify its economy to non-fossil fuel industries.[80] The funds generated by exporting fossil fuels could feed into the funding of non-fossil fuel industries, which, over time, would be rapidly phased out.[81]

Consideration Six – Fossil Fuel Dependency and Armed Conflict

As stated earlier in §3.2, countries such as Venezuela, Libya and Iraq may find their dependency on fossil fuels to be a crucial ingredient in maintaining some form of domestic stability. Transitioning to a low-carbon economy might be undesirable not only due to the ensuing economic issues, but also due to how the reliance on a particular industry, and the social fabric thereof, maintains some element of domestic stability (see §2.3 and Consideration Five). Additionally, several countries in the Middle East possess high carbon risk, and portray strong economic resilience but have several conflicts on their doorsteps. An example is Saudi Arabia, which is placed seventh highest concerning carbon risk, possesses strong economic resilience, but is surrounded by countries scoring high on the Conflict Vulnerability Layer, notably Yemen. Decreasing water supplies and population growth are a few of the factors driving the current conflict in which Saudi Arabia is involved militarily.[82] This is very indicative of

79 E. Hillbom, "Botswana: A Development-Oriented Gate-Keeping State," *African Affairs* 111, no. 442 (December 21, 2011), doi:10.1093/afraf/adr070.

80 Ibid.

81 Clingendael International Energy Programme (2014) Transition? What Transition? The Hague.

82 Collin Douglas. A Storm Without Rain: Yemen, Water, Climate Change, and Conflict https://climateandsecurity.org/2016/08/03/a-storm-without-rain-yemen-water-climate-change-and-conflict/ Center for Climate & Security Research.

the conversation that revolves around the economics of planetary security. With the potential impacts of a more specific climate change policy on the various sensitive domains in a nation like Syria, a broader reform agenda is needed, one which combines, for example, the transition to a low-carbon economy with a long term decrease of dependence on fossil fuel rents after the resolution of domestic conflicts.

Case Study China

Figure 11 China

China presents a unique example for the following reasons: it is the most vulnerable country to climate change, is remarkably domestically stable in spite of its undemocratic tendencies, has high economic resilience as the world's second largest economy, and faces medium conflict risk. China is the largest emitter of greenhouse gases and recently agreed to ratify the Paris Agreement (on climate change).[83] This, coupled with China's recent 13th five-year plan (March, 2016) in which greater environmental protection and a reduction of overall energy consumption were identified as key aims of the Chinese Government, could indicate a shift in China's overall approach to climate change.[84]

83 Tom Phillips, Fiona Harvey, and Alan Yuhas, "Breakthrough as US and China Agree to Ratify Paris Climate Deal," *The Guardian* (The Guardian), September 3, 2016, https://www.theguardian.com/environment/2016/sep/03/breakthrough-us-china-agree-ratify-paris-climate-change-deal.

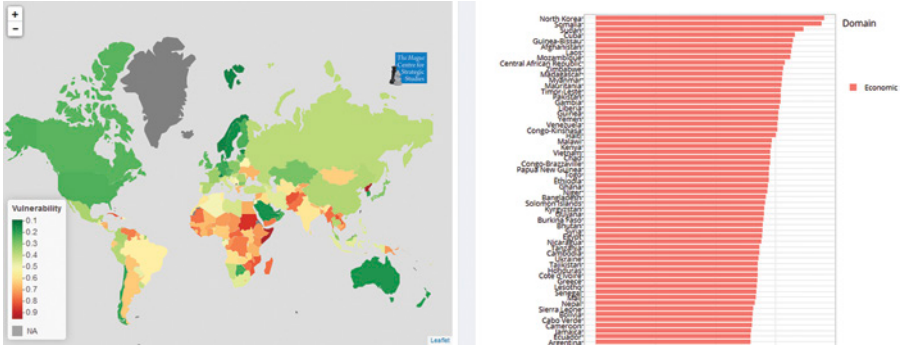
84 "Grantham Research Institute on Climate Change and the Environment," 2016, accessed September 1, 2016, http://www.lse.ac.uk/GranthamInstitute/legislation/countries/china/.

Food security and water security are tied into a variety of cultural and political factors in China, with the increasing affluence of the Chinese middle class able to afford more and moving to urban areas, leaving the rural populations – especially in the north – with little nutritional security. Many areas in the south lay in low transition zones where water bodies, and consequently agricultural yield, are already being reduced by climate change.[85] Given its size, large population, and geographic/topographic diversity, China's physical environment is complex. Recently, China has suffered from a rise in the number of extreme climate conditions. Again, the south has experienced extremely high temperatures and an increase in floods, mudslides and landslides, especially in the Yunnan Province. Coastal economic hubs in the east have also been facing an increase in storm-related activity.[86]

With China beginning to shift its attitude towards climate change, a transition to a low-carbon economy will be crucial in China's development and modernization. Such a transition would present opportunities for China to diversify its economy and strengthen its energy security. Its current, heavily polluting economic model is clearly unsustainable, and given the high economic resilience and low conflict vulnerability, China has the funds and relatively stable social climate to undergo such a transition. This is not only desired by Government officials, but locals in both rural and urban areas, as many feel their quality of life has been affected by the environmental pollution that has been instigated by China's current economic model.

Layer Four: Economic Resilience Analysis

Figure 12 An overview of the general outcomes of Layer Four in the monitor



85 Ibid.

86 Ibid.

The overall pessimistic scores in Layer Three – especially in comparison to other layers – are unsurprising considering how non-renewable energy is still widely used and is still the major source of energy to many states (see § 4.5). This shows a global trend in dependency on the export of fossil fuels; however, in the case of economic resilience, this report emphasizes the ease and attractiveness of investing into these countries for private entities. Firstly, Europe presents us with a relatively mixed picture where Mediterranean Europe does not seem to be performing as well as its Northern (particularly Scandinavian) counterparts, partly explained by their domestic deficits. Nevertheless, as a whole, Europe is performing quite well, with Greece and Ukraine as the only outliers. Asia, however, has differing results in South East Asia, while the Gulf and Eastern Asia are performing generally well (with the strong exception of North Korea). Southern Asia and the central region score quite regularly in the medium to low range.

Africa is less resilient overall, with high scores in low resilience around the continent, with the exception of a few Southern African states such as Namibia, Botswana and South Africa, and remarkably, Libya. South America too presents a wide range of scores, with some countries scoring high in terms of economic resilience, such as Chile, Peru, Colombia and Uruguay, and others quite low in terms of economic resilience, such as Venezuela and Argentina. North America, however, seems to be performing quite well, with the strong domestic economies of the USA, Canada and Mexico painting a more positive picture on the continent. Furthermore, Australia and New Zealand both score quite well on the economic resilience scale.

Top Ten: Countries with the least economic resilience

Table 14 The least economically resilient countries in Layer Four

Rank	Country	Score
1	North Korea	0.952
2	Somalia	0.941
3	Sudan	0.866
4	Cuba	0.83
5	Guinea-Bissau	0.822
6	Afghanistan	0.818
7	Lao	0.814
8	Mozambique	0.811
9	Central African Republic	0.788
10	Zimbabwe	0.781

The top ten here represents the least economically resilient countries. As mentioned earlier, the inverse of the final economic resilience scores were taken in order to conceptualize a high score as an undesirable trait (see §5.6). Somalia, again, features in the top ten, coming in second after North Korea. The variance across the data is quite high, with North Korea and Somalia considerably less economically resilient than third placed Sudan. Other nations such as Cuba and Lao have socialist and protectionist elements to them too: the isolationism of North Korea, Cuba and Lao naturally results in low economic resilience as all of the indicators are conceptualized from a capitalist perspective, which also partially explains why African countries also seem to perform quite poorly in terms of economic resilience. Afghanistan and Sudan, as conflict zones, score quite highly partially due to the sanctions placed on the respective states, and due to their lack of interaction with the international economy. Domestically unstable countries seem to occupy various positions in the top ten as well, with Zimbabwe, Central African Republic and Mozambique occupying the last three positions. Overall, six of the final ten are African, indicating the lack of development on the continent as a whole.

Bottom Ten: countries with the most economic resilience

Table 15 The most economically resilient countries in Layer Four

Rank	Country	Score
1	Luxembourg	0.094
2	Macao	0.127
3	Switzerland	0.138
4	Norway	0.142
5	Estonia	0.145
6	Hong Kong	0.160
7	Sweden	0.161
8	United Arab Emirates	0.164
9	Saudi Arabia	0.170
10	Australia	0.174

These are the most resilient countries, with Scandinavian countries performing quite well, possibly due to their high economic freedom scores and high credit rating, with the European debt crisis having not impacted Scandinavian states as severely as first predicted in 2008. All of these states have high GDP per capita. Saudi Arabia's appearance is largely due to their lack of debt. Hong Kong, Macao, Luxembourg and Estonia are ranked high predominantly due to their small country size and, more importantly, due to their dynamic and service driven economies.

In conjunction with Layer Three, four of these countries have high economic resilience and high carbon risk. For instance, Saudi Arabia, Australia, Norway and United Arab Emirates are all highly dependent on oil and fossil fuels as drivers of their economies and domestic energy industries. This may indicate that the transition from a carbon reliant economy to a low carbon economy may be affordable, but also more problematic.

Consideration Seven – The Role of Economic Resilience in Conflict-Vulnerable States

With many states scoring high in both conflict vulnerability and economic resilience (a high score denoting low resilience) it is important to look into the possible considerations for these countries. In the MENA region, with the exception of the oil rich states, many countries are caught in conflict and cannot maintain the stability needed to develop their economic resilience. How do less resilient countries get out of this rut? It is imperative to understand this dynamic, especially considering how climate change can potentially worsen the status quo if the conflict is not addressed first.

Economic resilience as a contributing factor to peace is, in essence, a domestic orientation of conflict prevention. A key step in this direction is the domestic government's ability to manage the process of transforming conflict into peace. With fragmented and disjointed responses of government, especially in Syria, Pakistan and Sudan, local capacities are often overlooked and subsequently under-strengthened.[87] Considering that most of the countries in the top ten either suffer from economic sanctions or a lack of interaction with the global economic system, domestic development remains unattainable if these countries are not further integrated into the international community.[88] Internationally, this presents itself as a conundrum: in the knowledge that these countries will experience some form of environmental stress – which, overtime, may worsen – and that these countries have a high degree of conflict vulnerability and a low degree of economic resilience, how can the international community assist these conflict nations in developing economic resilience? A cardinal reason why most of these countries have low economic resilience is merely because of their disconnect from the international financial system, either at their own accord – North Korea, Lao and Cuba – or by the international community itself through sanctions – Sudan, Afghanistan, Zimbabwe.[89]

87 Willene Johnson, *Policy Responses to Economic Vulnerability*, (United Nations Development Policy and Analysis Division: United Nations, 2006), http://www.un.org/en/development/desa/policy/cdp/cdp_background_papers/bp2006_9.pdf.

88 Ibid.

89 Ibid.

Table 16 The top 20 countries in the economic complexity indicator

Rank	Country
1	Japan
2	Switzerland
3	Germany
4	Sweden
5	USA
6	Korea
7	Finland
8	Singapore
9	Czech Republic
10	Austria
11	UK
12	Slovenia
13	France
14	Hungary
15	Netherlands
16	Slovakia
17	Ireland
18	Denmark
19	Israel
20	Mexico

Consideration Eight – Economic Complexity and Credit Rating and the Role of Private Investment

Economic complexity – which denotes the degree of economic diversification in an economy – is a crucial indicator in Layer Four as it shows what private entities may do if they aspire to invest in a country. The objective of this indicator is to explain the entire economic system and the parts involved, rather than as a mere sum of its parts.[90] Furthermore, complexity is an illustration of the various ways and economic means through which a state can respond to changes in environmental conditions. The greater your economic complexity, the greater a state's capacities to respond to the effects of climate change are, as complexity relates to the diverse range of approaches and methods a state can take in mitigating climate change effects.

90 Sami Mahroum and Yasser Al-Saleh, eds., *Economic Diversification Policies in Natural Resource Rich Economies* (Devon, United Kingdom: Routledge, 2016), 259.

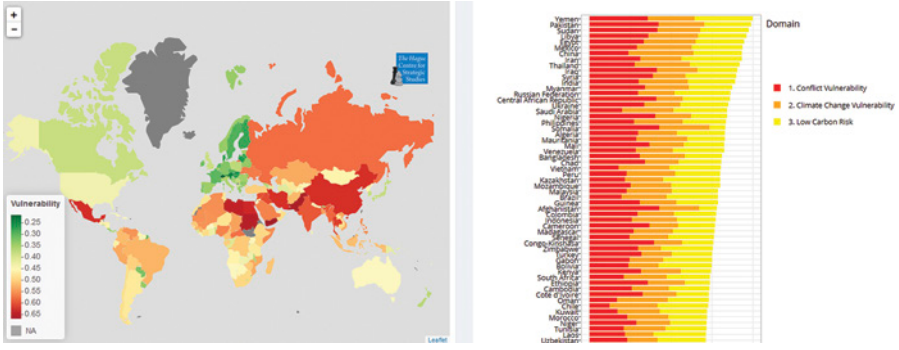
From the ranking it is evident that there is some form of regional bias in the states with the most economic complexity. These states are either European, North America (excluding the Caribbean and Central America) or South East Asian. From a private sector perspective, this allows businesses to not only 'experiment' in determining which adaptation action would be most appropriate, but also in finding which action would be the most cost effective.[91] However predicting the economic consequence of climate change effects and cost effectiveness is considerably difficult. The key here to countries with low economic resilience and economic complexity is how to adapt, and improve the sectors of economy upon which they are most reliant, as well as their ability to do so. For instance, farmers might switch to crops more tolerant to dry soil. Critically, however, this reliance on agriculture in less developed countries presents a conundrum, especially considering if these changes were to fail. An alternative viewpoint suggests that economic diversification is a key component of economic resilience as it will assist countries in the long term.

Discussion

So far, the model comprises a consolidated version of all the layers combined. This however excludes the ability to freely combine the different layers at the user's will (in a quantitative sense). Nonetheless, the benefits of cross-comparing the different layers to policymakers and business professionals alike give insight into: how to manage expectations, where the emphasis in policy/business plan implementation should be, the necessary measures needed to develop a coherent policy, and, lastly, how policies or business plans should be divided into stages.

Consolidated Risk Monitor

Figure 13 An overview of the general outcomes of the consolidated risk monitor



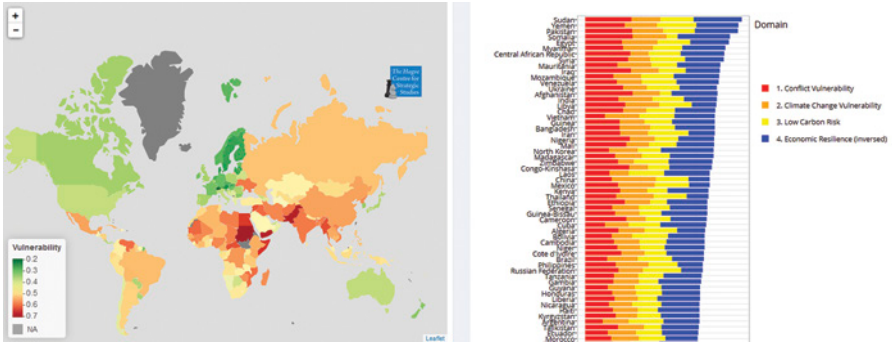
91 Ibid.

From the above image it is evident that Europe stands out as the least vulnerable continent (with the exception for Kaliningrad which scores in the high vulnerability range due to being Russian territory). Africa scores mostly on the medium to high vulnerability range, with the exception of North-Eastern Africa, which predominantly scores in the high vulnerability range. South America, with the exception of Paraguay (as a landlocked country), French Guyana[92] and Uruguay, have low vulnerability scores.

North America scores predominantly in the medium to low vulnerability range, with the exception of Mexico, which has a high vulnerability score. Meanwhile, Asia scores in the medium to high vulnerability range, with the exception of Japan and Bhutan. Oceania scores mostly in the medium to low vulnerability range.

Consolidated Resilience Monitor

Figure 14 An overview of the general outcomes of the consolidated risk and resilience monitor



The Consolidated Risk and Resilience Layer illustrates the degree of overall resilience to climate change effects. When reviewed against the Consolidated Risk Layer, the scores do not look quite so bleak: for instance, many states that are at risk have some economic capabilities to assist in mitigating such risks. With the exception of a few countries, the overall average score ranges in the medium mitigation range. With respect to the Consolidated Risk Layer, Asia fares better as it drops from being predominantly in the medium to high risk range to the medium risk range. This is, however, with the exception of Japan and South Korea, who both score low, and Pakistan and Yemen, who both score high. Africa continues this general trend, with most countries occupying the

92 French Guyana's data is computed as France's data. French Guyana is a French overseas territory.

medium scoring range. Botswana is the only African state with a low score, indicating its overall ability to mitigate climate change based on the various layers. This bodes well considering its high dependence on fossil fuel rents. Sudan has the highest consolidated score.

Conclusions and Recommendations

This chapter will first draw conclusions on the monitor itself, then on the uses of the monitor. Finally, it will arrive at the main recommendations for policy makers and business sector, and outline what research directions are further considered for the future.

The monitor

The economics of planetary security is a complex and, as of yet, largely unexplored area. It comprises general conflict factors within countries, potentially impacting the security of surrounding countries, and – in light of Layer Three – the risk factors in the global market related to environmental stress. The interlinkages between these variables mean that these layers can be considered as isolated components within the planetary security framework, but when taken together, they give a consolidated view of the economics of planetary security.

The monitor in its current form is an investigation into the economics of planetary security. Using the conceptual outline in the first half of the report serves as a lens through which to view the data. The indicators were operationalized to give a holistic understanding of the complexity of the economics of planetary security.

The most vulnerable countries in the **Conflict Vulnerability Layer (Layer One)** are located in the MENA region. The main underlying factors for this degree of vulnerability are the levels of political and socio-demographic instability, and insecurity observable in the region, implying the inability of these countries to withstand, or deal with such challenges. These results convey that the greater the inability of a given government to act, the greater their respective countries' overall vulnerability to conflict – hence the large presence of MENA countries in the top ten is to be expected. Such findings may potentially force policymakers to adjust their priorities with regard to what needs to be addressed first if planned climate change-related policies are to be effective.

The **Climate Change Vulnerability (Layer Two)** of a country includes the degree to which a country's environment is exposed to the harms of climate change by factoring in environmental, hydrological, geographic and topographic (land surface) concerns. When looking at the Climate Change Vulnerability factors, in general, the data shows that countries most vulnerable are located in the African Sahel and Horn of Africa regions. The main underlying factors causing the high degree of environmental

vulnerability in these regions are the lack of precipitation and the expansiveness of deserts present in these areas. Landlocked countries, such as Rwanda, Slovakia and Bhutan perform significantly better due to both the lack of precipitation volatility and that little of the population live below five meters above sea-level in these countries.

The Carbon Risk Layer (Layer Three) gives an indication of the vulnerability of a country to successful climate policies in the future, in particular those that will reduce fossil fuel use in the world economy. It includes a country's dependency on fossil fuels, fossil fuel resource rents of the countries, the proportion of electricity produced from oil sources, and the degree of renewable energy consumption. When looking at potential effects of low-carbon policies, Botswana, Iran and Yemen are found to be most vulnerable and at risk of unsuccessful transition. The main reason for this is their high dependency on export of fossil fuels as one of their main export industries.

The Economic Resilience Layer (Layer Four)

Combining Vulnerabilities

A more comprehensive view on country vulnerabilities arises when Layers One to Three are combined. The following countries appear most vulnerable or at risk to conflict: Yemen, Pakistan, Sudan, Libya and Mexico. These countries appear mostly due to their high scores in Layer One, due to the presence of conflict and due to their reliance on fossil fuels. Implementation is heavily predicated on a government's access to funds and the ability to mobilize resources in the right direction. Business professionals, in this regard, could supplement governments by consulting on how best to achieve such goals.

Combining Vulnerabilities with Economic Resilience

Drivers leading to increased economic resilience to climate change induced conflict include: higher market prices, unavailability of resources (to certain groups), scarcity of resources in general, higher population pressure, destruction of infrastructures and facilities potentially disrupting production and economic development as well as water management processes. When considering Layer Four in respect to these vulnerability layers, some countries might have greater economic capacity to deal with high vulnerability levels than others. For instance, according to our monitor Saudi Arabia and Australia both possess the economic capacity to transition from a carbon dependent economy to a low carbon economy. This is mostly attributed to their high credit rating, which may help in framing the attractiveness of investing in renewable energy, and a high GDP Per Capita.

Use of the monitor

The monitor developed can be used in various ways by policy makers and the business sector to assess vulnerabilities and resilience capacities of countries. For policy makers, this might entail taking action to address the main vulnerability factors identified in

both highly- and less-vulnerable countries alike. It could also mean allocating available resources first to the overall most vulnerable countries identified, and directing them to the necessary domestic industry. For the business sector, use of the monitor could potentially help to assess investment risks in countries under consideration and provide businesses with a further holistic understanding of what factors need to be incorporated in future implementation plans.

An example of this can be seen in the following categorization of countries. The purpose of this categorization is to assist policymakers in guiding their respective policies. These three categories indicate, in general terms, what steps can best be taken when creating policy, and how these countries should be dealt with by the international community.

Category A – Peace First, Development and Climate Resilience Later

The countries within this category are: Sudan, Pakistan, Afghanistan, Somalia and Yemen. These countries are characterized by high conflict vulnerability, high environmental stress and low economic resilience, and are also usually affected by war. For these countries, conflict is the overriding risk factor. When dealing with conflict areas it is advisable for policy makers to first prioritize establishing a stable foundation of peace before proceeding with policies that specifically target reducing environmental stress or improving economic resilience. For business professionals, this provides a contextual understanding of the country in which they may wish to invest.

Category B – Economies at Risk in a Low-Carbon World

The countries within this category are: Saudi Arabia, Russia and Australia. These countries are heavily invested in carbon and non-renewable energy, with the export of fossil fuels often a key ingredient in maintaining their levels of economic prosperity. Optimally, policymakers in these countries should prioritize establishing a good benchmark for transitioning into a low carbon economy without having long term damaging effects by expanding the degree of economic diversity domestically. The underdeveloped nature of certain economic sectors, such as Russia's renewable energy sector, could provide business professionals with ideas as to what they may best invest in.

Category C – Synthesizing Climate Change Mitigation with Development

The countries within this category are: China, Mexico and Thailand. These countries possess a strong economical basis with which they can develop policies that address both climate change resilience and development schemes. These could, for example, include implementing infrastructure programs that could increase domestic employment in order to combat hurricanes. Business professionals could audit such a process using our monitor in order to see the long term effects of changing development implementation schemes.

Recommendations

Developing resilience towards conflicts and to climate change is a multi-layered and multi-faceted challenge. Exploring the relationship between planetary security (climate change as a stress factor to conflict) feeds into the need to consider the effects of climate change on the economic resilience of a given state in order for it to be able to endure shocks to its economic system. What follows is a list of key recommendations that are based on the data both used and yielded by our monitor, as well as the qualitative considerations outlined within this report. Attention is paid to measures intended to increase resilience to climate change induced stress at a state and economic (private) level.

General recommendations for policy makers and business sector

1 Analyze impacts of economics on planetary security in an integrated way by looking at economic vulnerabilities and resilience factors alike and by integrating analysis of economic with non-economic conflict factors.
2 A further development of the monitor outlined in this report is required for such an analysis.

Specific recommendations for certain categories of countries identified in this monitor

Category A – Peace First, Development and Climate Resilience Later

3 Increase country resilience by identifying and addressing underlying societal, political, security pressures, which can then feed into tailored and precise policy making;
4 Investigate and identify joint responses of public authorities and the private sector in managing the process of conflict transition, taking into account the multi-layered conflict factors identified in the monitor.

Category B – Economies at Risk in a Low-Carbon World

5 Address the risks of a country's economic dependency on fossil fuel rents in a future low-carbon world;
6 Undertake a domestic analysis of the causes of conflict in the country in question to ensure policies are more effective. Policies must address the driving factors of the different layers of risk in the monitor;
7 Identify, address and align climate change policy and the transition towards a low-carbon economy, while addressing and streamlining actions combatting climate change effects;
8 Develop capacities for economic resilience: introduce policies transitioning to a low carbon economy. This is both an opportunity and challenge to both the public and private sector;

9 Diversify the economy of fossil fuel dependent countries, especially those in the MENA region prone to conflict. For more economically resilient countries and transnational corporations: develop tailor-made capacities or support for such countries.

Category C – Synthesizing Climate Change Mitigation with Development

10 Undertake a domestic analysis of the causes of maladies in the current situation of the country in question to ensure policies are effective. Policy has to address the driving factors of the different layers of risk in the monitor.
11 Prevent climate change mitigation and adaptation policies from becoming a new source of conflict through, for instance, addressing stove piping of climate change policies. This feeds into the need for comprehensive and balanced policies.

Future Research Required

Based on the report, it is recommended that the method for integral analysis of economics of climate change as a conflict factor is developed further. It is possible that new data, indicators and/or different methodological techniques could be needed to better capture the layers presented in the monitor. The lack of representative data for the private sector remains an issue, this being an integral element in including the private sector into the economics of planetary security equation. In particular, suggested further improvements of the monitor in the future are as follows:

- Strengthen and improve the monitor by testing the monitor against contemporary findings in conflict, climate change, low-carbon, and economic resilience analyses;
- Further discuss the selection of indicators and their implications from a scientific angle;
- Expand the monitor to include effects of climate change on the global business and financial sector[93];
- Include more private sector data in the Economic Resilience Layer;
- Improve the monitor to better reflect global trends and future risks in regards to planetary security.

93 This proved difficult as data on private organisations on a country level was difficult to find. The multi-national characteristics of TNCs propagated this issue further.

References

ADB. (2013). *The Economics of Climate Change in the Pacific*. Mandaluyong City: Asian Development Bank.

Alao, A. (2007). *Natural Resources and Conflict in Africa: The Tragedy of Endowment*. Rochester: University of Rochester Press.

Avory, B., Cameron, E., Erickson, C., Fresia, P., & Davis, J. (2015). *Climate Resilience and the Role of the Private Sector in Thailand*. New York: BSR.

Burton, J. (1990). *Conflict: Human Needs Theory*. Basingstoke: Palgrave Macmillan.

Chan, W. K. (2016). *Lexicon - Definition of Hockey Stick*. Financial Times.

Chandra, A., Moen, S., & Sellers, C. (2016). *What Role Does the Private Sector Have in Supporting Disaster Recovery, and What Challenges Does It Face in Doing So?* Santa Monica: Rand Corporation.

ChinaFAQs. (2016). *Why is China Taking Action on Clean Energy and Climate Change?* Washington, DC : World Resources Institute.

Coleman, P. T., Deutch, M., & Marcus, E. C. (2014). *The Handbook of Conflict Resolution: Theory and Practice 3rd Edition*. San Francisco: Jossey-Bass.

Collier, P. T., & Hoeffler, A. (2004). Greed and grievance in civil war. *Oxford Economic Papers 56*, 563-595.

Collier, P., Elliott, V. L., Hegre, H., Hoeffler, A., Reynal-Querol, M., & Sambanis, N. (2003). *Breaking the Conflict Trap: Civil War and Development Policy*. Oxford: The World Bank & Oxford University Press.

Douma, P. S. (2003). *The Origins of Contemporary Conflict: A Comparison of Violence in Three World Regions*. The Hague: Clingendael Institute.

Downey, D. C. (2016). Disaster Recovery in Black and White: A Comparison of New Orleans and Gulfport. *The American Review of Public Administration vol. 46 no.15*, 51-74.

Downing, T. E., Watkiss, P., Dyszynski, J., Butterfield, R., Devisscher, T., & Pye, S. (2009). *Economics of Climate Change in Rwanda*. Stockholm: Stockholm Environment Institute.

Eliasch, J. (2008). *Climate Change: Financing Global Forests*. Norwich: The Stationery Office Limited.

Femia, F., & Werrel, C. (2012, February 29). *Syria: Climate Change, Drought and Social Unrest*. Retrieved September 20, 2016, from The Center for Climate and Security: https://climateandsecurity.org/2012/02/29/syria-climate-change-drought-and-social-unrest/

Fetherston, A. B., & Nordstrom, C. (1995). OVERCOMING HABITUS IN CONFLICT MANAGEMENT: UN Peacekeeping and War Zone Ethnography. *Peace & Change - A Journal of Peace Research*, 94-119.

Goulder, L. H., & Pizer, W. A. (2006). *The Economics of Climate Change*. Washington, DC: Resources for the Future.

Hammes, T. X. (2006). *The Sling and the Stone: On War in the 21st Century*. Minneapolis: Zenith Press.

Heidelberg Institute for International Conflict Research. (2015). *Conflict Barometer No. 24*. Heidelberg: HiiK.

Henderson, G., Song, R., & Joffe, P. (2016, March 18). 5 Questions: What Does China's New Five-Year Plan Mean for Climate Action? *World Resources Institute*.

Institute for Economics & Peace. (2016). *Global Peace Index*. Sydney: IEP.

Institute for Economics & Peace. (2016). *Global Peace Index*. Sydney: IEP.

Insurance Information Institute. (2014, September). *Climate Change: Insurance Issues*. Retrieved from iii - Topics: http://www.iii.org/issue-update/climate-change-insurance-issues

International Bank for Reconstruction and Development / The World Bank. (2013). *Building Resilience: Integrating Climate and Disaster Risk into Development - The World Bank Group Experience*. Washington, DC: World Bank Publications.

International Tsunami Information Centre. (2004). *Tsunami Warning System in the Pacific*. Honolulu: Intergovernmental Oceanographic Commision.

IPCC-SEC. (2016). *Publications & Data*. Retrieved September 2, 2016, from Intergovernmental Panel on Climate Change: http://www.ipcc.ch/publications_and_data/publications_and_data.shtml

Kelley, C. P., Mohtadi, S., Cane, M. A., Seager, R., & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *PNAS vol. 112 no. 11*, 3241-3246.

King, E. (2013). China and Russia block UN Security Council climate change action. *Climate Home*.

Krause-Jackson, F. (2013). Climate Change's Links to Conflict Draws UN Attention. *Bloomberg*.

Lind, W. S., Nightengale, K., Schmitt, J. F., Sutton, J. W., & Wilson, G. I. (1989). The Changing Face of War: Into the Fourth Generation. *Marine Corps Gazette*, 22-26.

Manger, L. (2006). Resource Conflict as a Factor in the Darfur Crisis in Sudan. *Colloque international "Les frontières de la question foncière – At the frontier of land issues"*. Montpellier.

Mann, M. E., Bradley, R. S., & Hughes, M. K. (1998). Global-scale temperature patterns and climate forcing over the past six centuries. *Nature Vol. 392*, 779-787.

Marker, S. (2003). Unmet Human Needs. In G. Burgess, & H. Burgess, *Beyond Intractability*. Boulder: Conflict Information Consortium & University of Colorado.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review 50*, 370-396.

Max-Neef, M. A. (1991). *Human Scale Development: Conception, Application and further Reflections*. London: The Apex Press.

Mills, E. (2007). Responding to Climate Change – The Insurance Industry Perspective. *Climate Action - Sustainable Development International*, 100-103.

Ministry of Environment, Forest and Climate Change. (2012). *West Bengal State Action Plan on Climate Change*. Calcutta: Government of West Bengal.

National Intelligence Council. (2012). *Global Trends 2030: Alternative Worlds*. Washington, DC: NIC.

NATO Parliamentary Assembly. (2015). *RESOLUTION 427 on Climate Change and International Security*. Brussels: NATO.

Nokes, S. (2015, November 15). *Insurance industry aims to reduce huge losses from climate change extremes - Insurers count mounting costs of climate change and lobby to reduce the damage*. Retrieved from CBC News - Business: http://www.cbc.ca/news/business/insurance-climate-change-adaptability-1.3323132

Office of the Press Secretary. (2013). *Executive Order -- Preparing the United States for the Impacts of Climate Change*. Washington, DC: The White House.

Oppenheimer, M., Warren, R., Birkmann, J., Luber, G., O´Neil, B., & Takahashi, K. (2014). Emergent risks and key vulnerabilities. In F. Berkhout, P. Dube, W. Foden, S. Greiving, S. Hsiang, M. Jonston, et al., *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1039-1099). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Overby, S. (2005, September 16). Lessons from Hurricane Katrina: It Pays to Have a Disaster Recovery Plan in Place. *CIO*.

Owen, T. (2004). Human Security – Conflict, Critique and Consensus: Colloquium Remarks and a Proposal for a Threshold-Based Definition. *Security Dialogue vol. 35 (3)*, 373-387.

Prudential Regulation Authority. (2015). *The impact of climate change on the UK insurance sector*. London: Bank of England.

Ross, M. (1999). The Political Economy of the Resource Curse. *World Politics, 51, (2)*, 297-322.

Rüttinger, L., Smith, D., Stang, G., Tänzler, D., Vivekananda, J., Brown, O., et al. (2015). *A New Climate for Peace: Taking Action on Climate and Fragility Risks*. Berlin: Printprinz GmbH.

Salih, M. (2005). *Understanding the Conflict in Darfur*. Copenhagen: Centre of African Studies - University of Copenhagen.

Schaik, L. v., & Dinnissen, R. (2014). *Terra Incognita: land degradation as underestimated threat amplifier*. The Hague: Clingendael Institute.

Schleussner, C., Donges, J. F., Donner, R. V., & Schellnhuber, H. J. (2016). Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries. *PNAS vol. 113 no. 33*, 9216-9221.

Schweithelm, J., Kanaan, R., & Yonzon, P. (2006). *Confilict over Natural Resources at the Community Level in Nepal - Including its Relationship to Armed Conflict*. Burlington Vermont: ARD, INC.

Schweithelm, J., Kanaan, R., & Yonzon, P. (2006). *Conflict over Natural Resources at the Community Level in Nepal: Including its Relationship to Armed Conflict*. Burlington: United States Agency for International Development.

Shambough, G. (2016). *Economic warfare*. Retrieved from Encyclopedia Britannica - International Law: https://www.britannica.com/topic/economic-warfare

Stern, N. (2006). *The Stern Review: The Economics of Climate Change*. London: HM Treasury.

Stewart, H., & Elliott, L. (2013, January 26). Nicholas Stern: 'I got it wrong on climate change – it's far, far worse'. *The Guardian*.

Strategiya natsional'noy bezopasnosti Rossiyskoy Federatsii [Strategy on national security of the Russian Federation], Presidential Decree No.683 (December 31, 2015).

Tadjbakhsh, S., Kubo, H., & Konialis, E. (2009). *Human Security in Theory and Practice: An Overview of the Human Security Concept and the*. United Nations, Human Security Unit, Office for the Coordination of Humanitarian Affairs (OCHA).

Team Green Analytics. (2015). *The Economic Impacts of the Weather Effects of Climate Change on Communities*. Guelph: Insurance Bureau of Canada.

TEEB. (2010). *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*. (P. Kumar, Ed.) London: Earthscan.

The Global Facility for Disaster Reduction and Recovery. (2015). *Resilience to Climate Change: an Overview of Support Provided by GFDRR*. Berlin: GFDRR.

The Rockefeller Foundation. (2014). *Building climate change resilience in cities: The private sector's role*. New York: The Rockefeller Foundation.

U.S. Department of Defense. (2015). *National Security Implications of Climate-Related Risks and a Changing Climate*. Washington, DC: U.S. Department of Defense.

UNDFS. (2011, December). *Map No. 3690 Rev. 10*. Retrieved from United Nations Department of Field Support: http://www.un.org/Depts/Cartographic/map/profile/somalia.pdf

UNIFTPA. (2012). *Toolkit and Guidance for Preventing and Managing Land and Natural Resources Conflict - Renewable Resources and Conflict*. Gigiri: The EU-UN Partnership on Land, Natural Resources and Conflict Prevention.

Wilson, S. (2016, July 21). The Challenge and the Opportunity of Private Sector Climate Resilience. *Multilateral Investment Fund*.

World Commission on Environment and Development. (1987). Chapter 11: Peace, Security, Development, and the Environment. In *Our Common Future: The World Commission on Environment and Development*. Oxford: Oxford University Press.

Annex

Layer One Conflict Vulnerability Subdomains and Indicators

Table 17 Security subdomain and indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
Maximum Conflict Intensity (MEPV)	The systematic and sustained use of lethal violence by organized groups that result in at least 500 directly-related deaths over the course of the episode.[a] *The greater the intensity of conflict, the greater the vulnerability of the security domain.*[b]	MEPV, 2015.
Best Estimate from Death Toll from State-Based, One-Sided and Non-State Violence	An actor-year dataset with information on intentional attacks on civilians by governments and formally organized armed groups.[c] *The number of deaths from listed types of violence is used as an indication of the overall status of security in a country.*[d]	Uppsala Conflict Data Program, Time-Series data since 1970s.
Global Terrorism Index	The GTI measures the impact of terrorism [non-state actors] in 162 countries. To account for the lasting effects of terrorism, each country is given a score that represents a five year weighted average.[e] *The higher the impact of terrorism, the less control a state has over its security.*	GTI, 2014.
Political Terror Scale (PTS)	The PTS measures the levels of state-sanctioned or state perpetrated violence. This includes assassinations of political challengers or police brutality. The PTS represents a five point scale whereby countries are classified on the degree to which the population suffers from political violence.[f] *Political terror represents how susceptible a state is to using political violence.*	PTS, 2014.
Refugees Produced	Refugee movement here is interpreted as an indicator of the status of living in the host country. This can be interpreted two-fold: a) Refugees produced as an indicator of political/security strife; b) Refugees produced as an indicator of economic scarcity. *The outflow of refugees illustrates the lack of security people feel in a country, acting as a push factor to leave.*[g]	World Development Indicators (WDI), 2014.[h]

a ("Center for Systemic Peace," Center for Systemic Peace, accessed August 4, 2016, http://www.systemicpeace.org/inscr/MEPVcodebook2015.pdf.

b Jon Barnett and W. Neil Adger, "Climate Change, Human Security and Violent Conflict," Political Geography 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.03.003.

c "Sidan Har Flyttat/page Has Been Moved - Uppsala University, Sweden," Uppsala Universitet, September 20, 2016, accessed September 2016, http://www.pcr.uu.se/data/.

d Jon Barnett and W. Neil Adger, "Climate Change, Human Security and Violent Conflict," Political Geography 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.03.003.
e "Vision of Humanity," Vision of Humanity, accessed August 22, 2016, http://www.visionofhumanity.org/#/page/indexes/terrorism-index.
f "Documentation: Coding Rules," 2016, accessed August 8, 2016, http://www.politicalterrorscale.org/Data/Documentation.html#PTS-Levels.
g Rafael Reuveny, "Climate Change-Induced Migration and Violent Conflict," Political Geography 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.05.001.
h "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.

Table 18 Political subdomain and indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
Polity4 Score	The Polity4 Score displays periods of "factionalism" and important Polity change events such as autocratic backsliding, executive auto-coup or *autogolpe*, revolution, collapse of central authority (state failure), and successful military coups.[a] *The greater the degree of political change and factionalism the less cohesive the political system is.*	Center for Systemic Peace, between 1800-2014.[b]
Variance in Polity4 Score	The variance shows the actual degree of volatility at a country level which gives an indication of how likely change is going to arise, with continuous change characterized as instability. *The variance shows the actual degree of change as an indicator of political volatility.*	Center for Systemic Peace, 1996-2014.
Factionalism Dummy	Countries with political factions that regularly compete for political influence in order to promote particularist agendas and favor group members.[c] *The greater the degree of factional competitiveness of political participation the greater the likelihood of domestic conflict.*	Center for Systemic Peace, 2015.[d]
Rule of Law	As part of Freedom House's Freedom in the World, this indicator assesses the degree of Rule of Law. There is a points system in place (0-16) – the higher the figure the higher the degree of rule of law.[e] *The greater the rule of law the less vulnerable and more cohesive the political and legal system is.*	Freedom House, 2015.[f]
Control of Corruption	Control of Corruption includes the "perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests."[g] *Control of Corruption conveys the political cleavages between government and the populace.*[h] *The greater the corruption, the more political vulnerability.*	WDI, 2014.

a "Polity IV Project: Country Reports 2010," Center for Systemic Peace, June 6, 2014, accessed September 4, 2016, http://www.systemicpeace.org/polity/polity4.htm.
b Ibid.
c Ibid.
d Data is binary – either a country has coded as having a factional political system or not. It is based on the PARCOMP variable in Polity4 dataset (value 3 of that variable indicates a fractional political system.
e "Methodology," Freedom House, 2016, accessed September 4, 2016, https://freedomhouse.org/report/freedom-world-2016/methodology.
f Ibid.
g "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
h Jon Barnett and W. Neil Adger, "Climate Change, Human Security and Violent Conflict," Political Geography 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.03.003.

Table 19 Social and Demographic subdomain and indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
Infant Mortality	The number of infants dying before reaching one year of age, per 1,000 live births in a given year.[a] *Infant Mortality is used as an indicator of the overall health infrastructure in a country.*	WDI, 2015.
Life Expectancy at Birth	The number of years a newborn infant would live if contemporary patterns of mortality at the time of its birth were to stay consistent throughout its life.[b] *The greater the life expectancy at birth, the more capable (and less vulnerable) a state is in regards to ensuring the well-being of its people.*	WDI, 2014.
Human Development Index	Composite indicator which illustrates how having a long and healthy life, being knowledgeable, and having a decent standard of living improve development. *Human development Index is used as a representation of the overall level of social and demographic development in a country – the greater the degree of social development, the less vulnerable a state is to conflict.*	United Nations Development Program, 2014.
Ethnic Fractionalization	Ethnic fractionalization[c] reflects the probability that two randomly selected people from a given country will not share a certain characteristic, *the higher the number the less probability of the two sharing that characteristic.*[d]	Alesina et al., 2003.
Female Labor Participation	The number of women participating in the labor force and are economically active. *Higher levels of female labor participation are found to be significant in reducing the likelihood of intrastate armed conflict in some studies*	WDI, 2014.

a "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.

b Ibid.

c Alesina, Alberto, Arnaud Devleeschauwer, William Easterly, Sergio Kurlat, and Romain Wacziarg. 2003. "Fractionalization." Journal of Economic Growth 8: 155-94.

d Daniel N. Posner, "Measuring Ethnic Fractionalization in Africa," *American Journal of Political Science* 48, no. 4 (October 2004), doi:10.1111/j.0092-5853.2004.00105.x.

Layer Two Climate Change Vulnerability Subdomains and Indicators

Table 20 Precipitation, Sea and Water subdomain and indicators

Indicator (Sub-Domain)	Definition & *Brief Conceptualization*	Source, Year
Changes in Average Precipitation-*Coefficient of Variation* (Precipitation Sub-Domain)	Precipitation is the amount of water received by a country in the form of precipitation as a mean value over the course of a year. *The Coefficient of Variation (the ratio of standard deviation to the mean)* will highlight precipitation volatility. Studies have been conducted which provide a more methodologically astute measure of volatility, however our data is based on yearly annuals and aims to convey the digression from historical trends as an indicator of climate change vulnerability. *The greater the variation, the more volatile the changes in average precipitation, the more vulnerable a state is.*[a,b] *The Difference from Absolute Values* conveys the degree of change from the beginning of the time series data to the end. This does not take into account the direction of change (as in increase or decrease) but merely the extent of the change. *The greater the change, the more vulnerable.*[c]	World Bank, 1960-2014.[d]
Changes in Average Precipitation-*Difference in Absolute Values* (Precipitation Sub-Domain)		
Population Living Below Five Metres Above Sea-Level (Sea Sub-Domain)	Population Living Below Five Metres Above Sea-level is the number of people living below five metres above sea-level. *With a greater proportion of the population living below sea-level comes more vulnerability to the state.*	WDI, 2010.
Water Stress (Water Sub-Domain)	"Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity."[e] *The more exposed a country is to water stress, the more the domestic population is competing for limited water supplies. In terms of vulnerability, the more competition the more vulnerable a state is to the impact of climate change due to the deterioration of water volume.*[f]	World Resource Institute, 2020.[g]
Renewable Internal Freshwater Resources Per Capita (Water Sub-Domain)	"Renewable internal freshwater resources flows refer to internal renewable resources in the country."[h] *This is an indicator of the available natural freshwater bodies in a country. In taking the data "per capita" the monitor illustrates how much freshwater an individual in the country has access to. The greater the access to internal freshwater, the less vulnerable a state is to climate change as climate change is expected to impact internal freshwater levels.*	World Bank, 2014.[i]

a Larger countries are more likely to experience fluctuations in the recording data because of the sheer size of the territory they encompass, meaning that if data is taken from different locations in a state it may distort the data.

b Aradhana Yaduvanshi and Ashwini Ranade, "Effect of Global Temperature Changes on Rainfall Fluctuations over River Basins Across Eastern Indo-GangeticPlains," Aquatic Procedia 4 (2015), doi:10.1016/j.aqpro.2015.02.093.

c David Dunkerley, "Effects of Rainfall Intensity Fluctuations on Infiltration and Runoff: Rainfall Simulation on Dryland Soils, Fowlers Gap, Australia," Hydrological Processes 26, no. 15 (November 15, 2011), doi:10.1002/hyp.8317.

d "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.

e "Share with Others," European Environment Agency, May 31, 2007, accessed July 2016, http://www.eea.europa.eu/themes/water/wise-help-centre/glossary-definitions/water-stress.

f Matti Kummu et al., "Is Physical Water Scarcity a New Phenomenon? Global Assessment of Water Shortage over the Last Two Millennia," *Environmental Research Letters* 5, no. 3 (July 2010), doi:10.1088/1748-9326/5/3/034006.

g The Water Stress data is divided into ten year intervals, with each interval (2020, 2030, 2040), divided into three scenarios: baseline, optimistic and pessimistic. For our study, the baseline 2020 data was taken due to it being the most recent dataset, without any weighting to distort the data to convey a more pessimistic or optimistic scenario.

h "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.

i Ibid.

Table 21 Land and Disaster subdomain and indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
Percentage of Desert of a Country (Land Sub-Domain)	With a lack of sufficient data on desertification and the rate of desertification, it was decided to use the percentage of desert land of a country as a proxy for desertification. *"Land degradation in arid, semiarid and dry sub-humid areas resulting from various factors, including climatic variations and human activities."*[a]	Nunn and Puga, 2012.[b]
Arable Land (Land Sub-Domain)	The amount of land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow, per person in a country.[c] *With arable land being measured in hectares per person as opposed to as the percentage of total land, there is more emphasis on a per capita understanding of vulnerability.*[d]	WDI, 2013.
Vulnerability to Weather-related Disasters (Drought, Floods, Storms & Extreme Temperatures) Disaster Sub)	Borrowed from EM-DAT, this indicator is a composite indicator incorporating drought, floods and extreme temperatures as a percentage of the average population. Instead of using a single indicator for drought[e], floods and extreme temperatures respectively, this indicator provides an overall sense of vulnerability in regards to weather-related disasters by factoring in storms, with a ten year moving average. In assessing the vulnerability to weather-related disasters, "[HCSS] consider[s] the number of people that were either killed or wounded or became homeless as a result of weather-related disasters as a percentage of the overall population over the last two decade."[f] *The indicator illustrates that extreme weather changes caused by climate change are increasing. It relates to vulnerability as what was previously regarded as single weather-related disaster episodes is now becoming more frequent and less abnormal.*	EM-DAT, 2015.[g]

a "*United Nations Convention to Combat Desertification*," 2012, accessed August 16, 2016, http://www.unccd.int/en/Pages/default.aspx.

b "Data on Terrain Ruggedness and Other Geographical Characteristics of Countries," February 1, 2012, accessed September 4, 2016, http://diegopuga.org/data/rugged/.

c "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.

d Clionadh Raleigh and Henrik Urdal, "Climate Change, Environmental Degradation and Armed Conflict," *Political Geography* 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.06.005.

e Patrick Meier, Doug Bond, and Joe Bond, "Environmental Influences on Pastoral Conflict in the Horn of Africa," *Political Geography* 26, no. 6 (August 2007), doi:10.1016/j.polgeo.2007.06.001.

f HCSS, Climate Change Vulnerability Monitor, (The Hague: HCSS, n.d.).

g "The International Disaster Database," The International Disaster Database, 2009, accessed August 4, 2016, http://www.emdat.be/.

Layer Three Low Carbon Risk Indicators

Table 22 Layer Three Indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
Rents from the Following Resources: Oil, Gas, Mineral, Forests and Coal	The rents from different resources are calculated by subtracting the production costs of resources from their market prices.[a] *The higher the rents from resources, the more dependent a country is on their production and export, which indicates the economic effect that a potential transition to a low carbon economy would have.*	WDI, 2014.[b,c,d,e,f]
Electricity Production from Sources of Oil	Different sources of oil are diverse, ranging from crude oil to petroleum products. The use of electricity is crucial in improving local quality of life. However, electricity use can also damage the environment. *High proportion of electricity production from oil sources indicates high cost of transition to renewable energy production.*[g]	WDI, 2014.[h]
Renewable Energy Consumption	Proportion of renewable energy consumption from total energy consumption. *High renewable energy consumption indicates readiness for low carbon economic model.*	WDI, 2014.[i]
Greenhouse Gas Emissions	Greenhouse gas (CO2, CH4, N2O, F-gases) emissions in CO2 equivalent kilotons in 2010. *High greenhouse gas emissions indicate the cost of restructuring to low carbon economy*	Data from the JRC EDGAR between 1990, 2010.[j]
Greenhouse Gas Emissions (change from 1990)	Proportion of greenhouse gas emissions in 2010 compared to 1990 levels (2010 value divided by 1990 value). *Changes in greenhouse gas emissions indicates steps taken in recent years to decrease carbon footprint.*	Data from the JRC EDGAR between 1990, 2010.[k]

a Subhes C. Bhattacharyya, "Fossil-Fuel Dependence and Vulnerability of Electricity Generation: Case of Selected European Countries," *Energy Policy* 37, no. 6 (June 2009), doi:10.1016/j.enpol.2009.02.031.
b "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
c Ibid.
d Ibid.
e Ibid.
f Ibid.
g Willem L. Auping et al., "The Geopolitical Impact of the Shale Revolution: Exploring Consequences on Energy Prices and Rentier States," *Energy Policy* 98 (November 2016), doi:10.1016/j.enpol.2016.08.032.
h "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
i Ibid.
j "Emissions Database for Global Atmospheric Research," Joint Research Centre, April 2010, accessed September 4, 2016, http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2014.
k Ibid.

Layer Four Economic Resilience Indicators

Table 23 Layer Three Indicators

Indicator	Definition & *Brief Conceptualization*	Source, Year
GDP per Capita, PPP (Current International $)	GDP per capita is "based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates."[a] *The greater the GDP PPP, the more resilient a country is in mitigating climate change.*	CIA Factbook, 2015.[b]
External Debt ($)	Total external debt is debt owed to non-residents repayable in currency, goods, or services.[c] *External indebtedness affects a country's credit rating and investor perceptions, thus mitigating their economic resilience.*	IMF, 2015.[d]
Economic Complexity Index	The Economic Complexity Index is the degree to which a country's economy is diverse and ubiquitous, these being desirable traits in economic resilience. *"The complexity of an economy is related to the multiplicity of useful knowledge embedded in it."*[e] *The greater the complexity, the more economic resilience.*[f]	MIT Media Lab Macro Connections group, 2015.
Credit Rating	The credit rating is the evaluation of risk of a potential debtor, evaluating their ability to pay back the debt. *The higher the credit rating the greater the level of economic resilience.*	Trading Economics, 2015.[g]
Labour Force	"The labour force is the supply of labour available for producing goods and services in an economy. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time job-seekers."[h] *The larger the labour force, the more people a state has to mobilize its resources.*	WDI, 2014.[i]
Index of Economic Freedom	The Index covers 10 freedoms – from property rights to entrepreneurship – in 186 countries. "In an economically free society, individuals are free to work, produce consume and invest in any way they please", while governments allow the processes thereof to occur without constraint of liberty beyond the "extent necessary to protect and maintain liberty itself."[j] *The greater the economic freedom, the greater the ease of doing business in a country.*	Heritage Foundation, 2015.[k]

a "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
b "The World Factbook — Central Intelligence Agency," CIA World Factbook, accessed September 28, 2016, https://www.cia.gov/library/publications/the-world-factbook/rankorder/2001rank.html.
c "World Development Indicators," 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
d "External Debt Statistics Guide and the IMF," International Monetary Fund, August 1, 2005, accessed September 8, 2016, https://www.imf.org/external/np/sta/ed/ed.htm.
e http://atlas.media.mit.edu/en/resources/economic_complexity/.

f Templet, Paul H. “Energy, diversity and development in economic systems; an empirical analysis.” *Ecological Economics* 30, no. 2 (1999): 223-233.
g “Credit Rating,” Trading Economics, 2016, accessed September 22, 2016, http://www.tradingeconomics.com/country-list/rating.
h Ibid.
i “World Development Indicators,” 2016, accessed August 4, 2016, http://data.worldbank.org/data-catalog/world-development-indicators.
j “2016 Index of Economic Freedom,” 2016 Index of Economic Freedom, 2016, accessed September 22, 2016, http://www.heritage.org/index/about.
k Ibid.

Criteria Set

Prior to determining the indicator sets in the analytical framework, guidelines which stipulate the prerequisites that each indicator must have before inclusion were prepared. The following section outlines these prerequisites. The selected indicators provide an important source of information for policymakers and business professionals and help guide decision making for the private sector. There are many benefits in providing a robust set of procedures on selecting relevant indicators in regards to a particular study. Most indicator selection is driven by the historical practices in choosing these indicators based on previous studies and on the degree to which each indicator meets a set of criteria individually. Due to the integrative nature of the analytical framework, we incorporated the relatability of each indicator within its respective layer as well as its place in the overall framework.[94]

Specificity – Firstly, the indicator has to be conceptualized in a manner which expresses the gist of the layer. For instance, volatile precipitation has to capture climate change vulnerability. Without a clear and unambiguous definition the indicator will be more susceptible to scrutiny, challenging the relevance of the indicator to the layer.[95]

Measurability – Indicators must be precisely defined so that their measurement is clear.[96] This relates to how the data is interpreted by the monitor users. Generally, this means that quantitative data must be easily interpreted by the user. Data measurements must have the capacity to be subject to methodological changes in the case of aggregating the data and developing a composite indicator.[97]

Integrative Components – In light of the fact that the monitor will contain aggregates of various indicators, the relatability of each indicator to one another remains crucial.[98] As such, we consider that each indicator must be conceptually relatable to other indicators within the same layer.

94 David Niemeijer and Rudolf S. de Groot, "A Conceptual Framework for Selecting Environmental Indicator Sets," *Ecological Indicators* 8, no. 1 (January 2008), doi:10.1016/j.ecolind.2006.11.012. 15

95 Allen L. Hammond and et al, *Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development* (Washington, D.C.: World Resources Institute, 1994). pg 11.

96 David Niemeijer and Rudolf S. de Groot, "A Conceptual Framework for Selecting Environmental Indicator Sets," *Ecological Indicators* 8, no. 1 (January 2008), doi:10.1016/j.ecolind.2006.11.012. 15

97 Allen L. Hammond and et al, *Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development* (Washington, D.C.: World Resources Institute, 1994).

98 Ibid.

Reliability – Is the data consistent over time? Is the data easy to quantify and presentable? Reliability includes the relevance of the chosen time scale, the gaps in data and the structure of the data. It is often the case that when something is more reliable then it is more quantifiable, therefore resulting in improved overall consistency of a measure.

Methodological Notes

The quantitative research was undertaken in the following manner: firstly, we developed a conceptual framework of the quantitative layers involved in the study and how they would express data in relation to one another. Secondly, those layers were then divided into subdomains in order to allow users of the monitor to further capture a particular aspect. This process also took into account data availability. Thirdly, we decided on a set of indicators which we would explore based on the criteria outlined in the previous page. The data and indicators had to be reliable and valid, and preference was given to data sources that had application programming interfaces (APIs). We then acquired the data, and employed a number of tidying and transformation techniques to create a structure and format that could best capture the specificity of each layer and the aggregation of all layers. We used the R programming environment for all of our data collection, tidying, transformation, imputation and visualization tasks. We then assessed the fullness of the indicator datasets and chose ones with the best data coverage and lowest number of missing values. As a number of datasets we used did not have data for countries with populations of less than 500,000 people, we left those countries out of our analysis.

Our next phase of research dealt with any remaining missing values. Layers One and Two have a very limited number of missing values that do not follow any particular pattern. After all the data of a particular layer was joined into one data frame, missing values were then imputed using multiple imputation (predictive mean matching with 5 imputations). For the first two layers, the number of missing values per indicator ranged from two (in the cases of precipitation and disasters data) to 13 missing values (for water stress data). For Layers Three and Four, the number of missing values was higher for some variables, so in order to avoid biases, missing values were not imputed.

The data for each layer were then normalized between 0 and 1 by using percentile ranks, with 1 indicating the least desirable figure (1 being the most vulnerable or most at risk, or least resilient). The indicator data was aggregated to a subdomain level using arithmetic means, which was previously conceptualized based on the similarity of the elements as expressed by indicators. There was a small difference in calculation between Layers One and Two when compared to Layers Three and Four: namely, in the first two layers the missing values had been replaced by imputed values, however these missing values remained in Layer Three and Four. The latter two layers' mean was taken over all non-missing values, and in the first two layers imputed values were included in

the calculation. Next, the domain index was calculated by taking the arithmetic means of subdomain index values, to give a general understanding of the layers used in the analysis. Finally, an overall composite of all layers, as well as a composite of the first three layers, was calculated using the same arithmetic means as before.

The resulting data was then visualized on an interactive choropleth monitor, with one separate map for each layer, as well as one for overall composite, and one for the composite of three vulnerability layers (which omitted the resilience layer). Countries used in the analysis were color-coded according to the index values of the layer, with red indicating high vulnerability or risk, yellow implying medium risk or vulnerability and green denoting low values of those indices. In a pop-up format, monitor users can see the vulnerability by indicator, illustrated by a spotlight graph. On a bar chart next to the map, users can observe country vulnerability rankings by layer, with different subdomains color-coded.