PBL Netherlands Environmental Assessment Agency

PLANETARY SECURITY: IN SEARCH OF DRIVERS OF VIOLENCE AND CONFLICT

Part I: National-scale databases and reliability issues

Background Report

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Planetary security: a search for drivers of violence and conflict.
Part I: National-scale databases and reliability issues

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The potential links between climate change, weather patterns, migration and conflict have received growing attention from scientists, media and global institutions over the last decade. But despite the increasing role that climate change has played in global security analyses and conventions, research on these topics has not fully matured or reached consensus on the existence of causal relationships. As for drivers of conflicts, violence and migration multiple explanations are found in the literature, varying from poverty and inequality, availability of resources (fertile land, ores, oil, water), grievances and greed, ineffective governance and corruption, to water-related impacts of climate change.

To deepen scientific insights in these complex processes and to strengthen the knowledge–policy interface, PBL Netherlands Environmental Assessment Agency participates in the Planetary Security Initiative. Recent studies highlighted the central role of water — too little, too much, too dirty — and the links between water security and conflicts. See the following reports: 'The geography of future water challenges' (Ligtvoet et al., 2018) and 'Linking water security threats to conflict' (De Bruin et al., 2018).

In the present study, we choose a wider scope. We explore and analyse a broad range of global databases containing human security indicators on country scale, varying from socio-economic indicators, climatic/weather indicators, indicators for food production to political indicators (corruption, governance, conflicts and violence). We publish our results in two parts. The present report — Part I — gives an overview of indicators, indicator frameworks and related composite indicators in the context of climate change, human security and conflicts. Part II deals with the statistical analysis of these data in order to explore the drivers of violence and conflict in more detail.

The results reported here show the availability of a wealth of indicators and indicator frameworks, published by a great variety of organisations: national and international institutes (such as the EU Joint Research Centre, UNHCR, FAO or the World Bank), universities, think tanks and reinsurance companies. These databases have multiple applications:

- monitor human security issues such as formulated in the Sustainable Development Goals (SDGs),
- support research in the field of disaster risk reduction (such as for the UN Office for Disaster Risk Reduction and the Sendai Framework),
- support climate change adaptation research (e.g. IPCC, 2018, Chapters 3, 4 and 5),
- identify hotspots of conflict and violence, this to prioritise humanitarian aid programs,
- feed statistical analyses and integrated assessment models that aim to analyse and predict impacts of climate change (poverty, water-related tensions, migration flows, conflicts).

Examples of institutes that base their humanitarian aid program on humanitarian risk indicators, are the World Bank and the Central Response Fund (CERF). CERF is part of the

UN Office for the Coordination of Humanitarian Affairs (UN-OCHA). The Netherlands is a major funder of CERF and donated USD 750 million over the 2006–2018 period.

We give an overview of the following data sources, without being complete: databases on natural disasters (CRED, Munich Re, GermanWatch, UNISDR), indicators on food security and water (FAO), demography and youth bulges (UN Development Programme), indicators on economic development, corruption and governance (World Bank, Transparency International), world happiness perception data (Sustainable Development Solutions Network), conflict-related indicators (UCDP, the Institute for Economics & Peace), indicators for migration, refugees and displaced people (UNHCR, IDMC, UN-DESA, IOM), and human security indicators (INFORM database of the EU Joint Research Centre, the CERF risk indices, Fragile States indicators of the Fund for Peace).

All these institutes and databases are briefly reviewed along with relevant metadata. In addition, we show how these indicators and indicator frameworks — all gathered on country basis — have been integrated into one database for 191 countries in the world, in line with database set-up chosen by the JRC for their INFORM database. All software implementations are within the statistical package S-PLUS, which is closely related to R. Occasionally, changes had to be made manually, for example, to merge databases properly (e.g. a computer sees 'Cote d'Ivoire', 'Côte d'Ivoire' and 'Ivory Coast' as three separate countries).

An important question is the *reliability* of all these data. Reliability of data is important since poor numbers will be found in poor and fragile countries with low levels of statistical capacity. However, these countries might need humanitarian/financial aid the most. The importance of this issue has been illustrated by Morten Jerven in his 2013 book entitled 'Poor numbers: how we are misled by African development statistics and what to do about it'. To get a grip on reliability issues we identified a number of uncertainty sources and propose ways to check the quality of specific indicators, with special reference to individual countries. One suggestion is to incorporate the World Bank national-based statistical capacity indicator in statistical analyses.

Furthermore, we show how all sources of uncertainty interact by comparing a range of composite indicators published by various institutes. These comparisons are based on visual presentations (scatterplot matrices based on 191 countries) and corresponding statistics (correlation matrices). The results vary across the composites chosen. For example, indicators for governance and corruption show surprising **high** correlations (correlations between 0.63 and 0.98). However, those for the impacts of natural disasters correlate **low to very low** (correlations between 0.15 and 0.52). These low correlations can be explained from deviating choices made by institutes as for disaster impacts (people affected, people killed and/or economic damage), in combination with absolute or relative impact measures (i.e., impacts relative to population size or GDP).

Finally, we compare three composite indicators for 'total risk' as published by CERF, JRC and the Fund for Peace. These three composites show a strong coherence (correlations ≥ 0.84), which is an important positive finding since financial aid in humanitarian crises are based on these indicators.

1 Introduction

1.1 Setting the scene

The potential links between climate change, weather patterns, migration and conflict have received growing attention from scientists, media and global institutions over the last decade. The global risk report 2016 by the World Economic Forum presented the failure of climate change mitigation and adaptation and water crises as respectively the first and third most impactful global risks posing significant threats to people, institutions and industries (World Economic Forum, 2016). But despite the increasing role of climate change in global security analyses and conventions, research on climate, weather and conflict has not fully matured or reached consensus on the existence of causal relationships.

An influential study by Hsiang and Burke (2014) found evidence that climatic events, both slow and fast onset events, influence numerous types of conflict at all scales based on the examination of 50 quantitative empirical studies. However, the study's conclusion that there is strong support for causal associations between climatological changes and conflict has been questioned and criticised by a leading group of scientists, for three reasons. Buhaug et al. (2014) argue that (i) there is a considerable overlap between the case studies used, (ii) the studies used are too heterogeneous to assume causal homogeneity, and (iii) the studies used are not representative for the overall field of inquiry.

The discussion between Hsiang and Burke (2014) and Buhaug et al. (2014) is an exemplary example of the lack of consensus on direct and causal relationships. But quantitative evidence of risks related to climate and conflict dominate in current discussions about security implications, and are of major importance for policymakers (Detges, 2017). There is increasing evidence though that the effects of climate change, mainly manifested via water-related hazards, negatively affect human security in various ways and that these impacts will increase (Adger et al., 2014). Especially poor people in fragile countries are likely to be hit, increasing social and economic inequality (World Bank Group, 2016).

In this report, a broad range of global databases have been quantitatively linked on country level, in order to analyse relationships between socio-economic indicators, climatic/weather indicators, indicators for food production and political indicators, and to assess reliability of databases covering corresponding topics. Since climate change and weather manifest itself mainly via water-related hazards, special attention has been given to water-related indicators. Examples are the impacts of weather-related disasters (droughts and floods), a measure for aridity and the accessibility of clean water sources per capita.

Relationships between socio-economic, environmental and political variables are complex and context specific. Maps and graphs based on statistical analysis can tell stories that make this information easier to understand. Figure 1.1 provides an in-depth example.

The graph shows areas with varying amounts of precipitation, climate hot spots, locations of oil and natural gas extraction, locations of silver, gold and uranium mines, human-made water canals and pumps, locations of frozen and active conflicts, military presence of army from the USA, Europe and Africa, locations of UN peace keeping operations, main migration routes, and more.

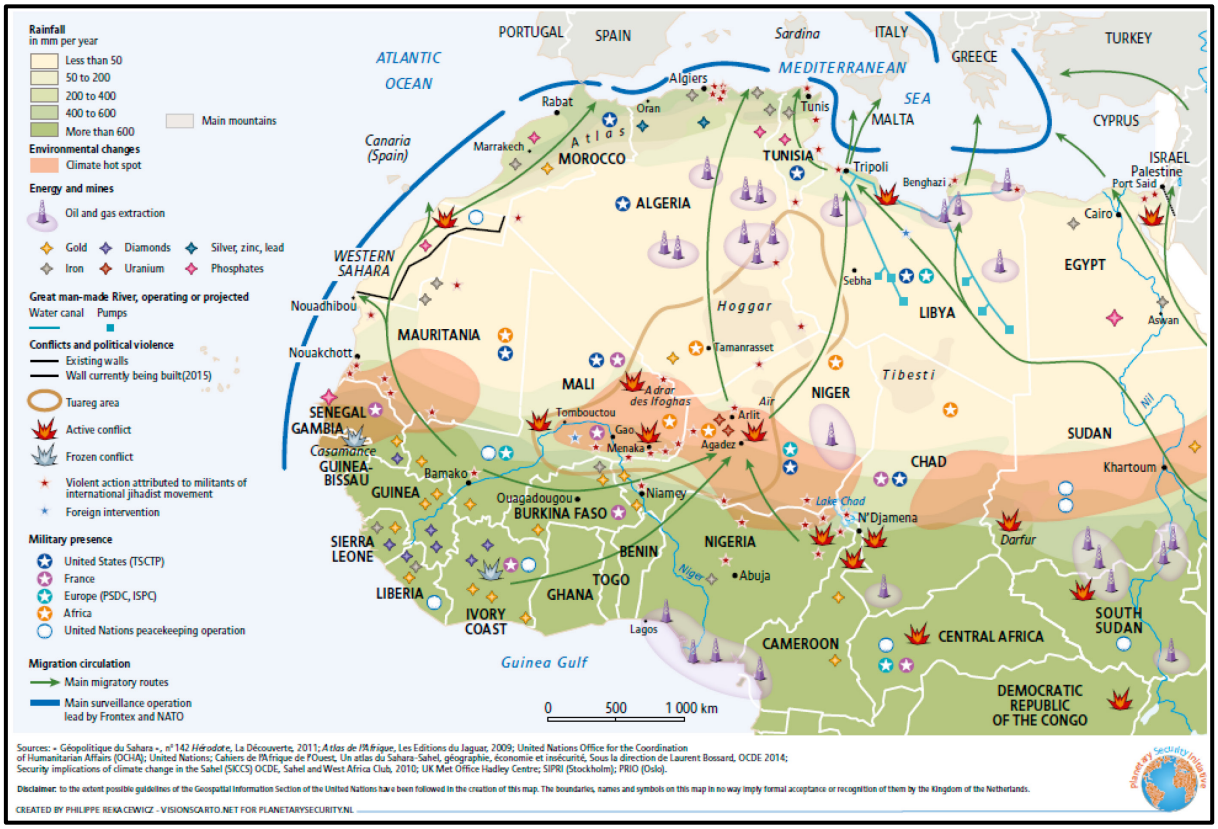


Figure 1.1 Sub-Saharan Africa including infrastructures, military presences, oil and natural gas extraction, mines, rainfall, climate hotspots, conflicts and migration (PSI, 2015).

But like all scientific methods, quantitative statistical analyses have their limitations, as no method is superior to all other forms of research on climate and conflict. It is therefore important to combine insights from qualitative and quantitative forms of research. This report is directed to the quantitative, statistical approach, but is linked to the PBL hotspot study entitled 'The Geography of Future Water Challenges', commissioned by the Interdepartmental Water Cluster (IWC). See Ligtvoet et al. (2018) and the more qualitative reports on climate, water and conflict relationships: Ligtvoet et al. (2017) and De Bruin et al. (2018).

We note that the study presented here has strong links to the Sustainable Development Goals (SDGs), shown in Figure 1.2. Many water-related indicators show such links (Ligtvoet et al., 2018, pages 12 and 13). A number of other indicators addressed in this report, have such connections as well. We name Good Health and Well-being (SDG 3),

Reduced inequalities (SDG 10) and Peace, Justice and strong Institutions (SDG 16). Also see the PBL infographic publication on SDGs.

Next to that, this report has links to the IPCC special report on the impacts of global warming of 1.5 ºC above preindustrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (IPCC, 2018). Many indicators discussed in this report are linked to adaptation and governance issues addressed in the IPCC Chapters 3, 4 and 5.

Figure 1.2 Overview of the 16 Sustainable Development Goals (SDGs) as presented on the UN Sustainable Development knowledge platform. Many of the global indicators and global composite indicators presented in this report are related to these SDGs, notably to SDGs 1, 2, 3, 4, 5, 6, 8, 10, 13, 15 and 16, and may well serve for monitoring purposes.

1.2 Conceptual approach, quantitative analyses

What are the major origins and drivers of the various types of conflict? Sorting out the main causes of conflict and war is difficult and often shaped by ideological beliefs. Even today, historians and political scientists still debate the primary causes of the First World War (Collier, 2007).

There are several types of conflict, ranging from state failure, international and civil war to local conflict, riot and revolution. There are numerous theories that explain the various types of conflict, which mostly focus on economic conditions and a range of factors that can foster grievances and greed, creating the incentive for people to initiate or join a conflict. People

and the organisations they belong to, need reasons to start a conflict, whether these are legitimate or not. Limited prospects for development, poverty, large economic and social inequality (e.g. discrimination), grievances due to former conflict, and unequal distribution of resources can all be motives for rebellion against authorities (Collier, 2007; Bara, 2014).

These perceived reasons to start a conflict may only materialise under certain circumstances. A united and competent regime will be able to handle potential insurgents as well as shocks such as natural disasters, while under weakened and paralysed regimes, insurgencies may lead to civil war or oppression (Goldstone et al., 2010; Besley and Persson, 2011).

In this report, several conditions affecting conflict risk in a broad sense are introduced that are deliberated in academic and popular literature. A number of these conditions or 'drivers' are summarised in the lower left part of Figure 1.3. This graph is taken from Ligtvoet et al. (2018) and illustrates how conflict and violence relates to (i) water-related impacts and climate change, and (ii) migration and displacement. However, the graph shows that other drivers, such as governance quality, economic inequality or the history of local and regional conflicts in countries, also are connected to violence and conflict.

In part, these connections are illustrated in the report of De Bruin et al. (2018) where water security threats are explored in relation to conflict. Here, 10 pathways are identified that clearly show how water security and other drivers of conflict such as inequality, grievances, (local) poverty or economic shocks are interwoven.

The approach in the present study is to identify a *hierarchy* in conflict drivers - shown in Figure 1.3 - using various statistical techniques, ranging from scatterplot matrices and correlation matrices to non-linear regression tree analysis in a multivariate setting of potential drivers. Such a hierarchy might allow a prioritisation in diplomatic and security policy agendas as formulated within the Planetary Security Initiative. This initiative was launched in 2015 by the Netherlands Ministry of Foreign Affairs.

It has to be noted that the outbreak of a conflict is multifaceted and the effects and complex interactions of conflict variables are context specific. This makes *predicting* conflicts hard and controversial (Cederman and Weidmann, 2017). Therefore, our aim is to identify direct, intermediate and more fundamental drivers of conflict and violence rather than predicting such outbreaks, as done by Fearon (2010), Goldstone et al. (2010), Hegre et al. (2011, 2016), Ward et al. (2013), Halkia et al. (2017) and Witmer et al. (2017). Here, we interpret the term 'driver' not persé in terms of a 'causal relation', but more in terms of conditions that relate to violence and conflict. The topic of causality in relation to our findings will be addressed in a separate Section.

Figure 1.3 Scheme taken from Ligtvoet et al. (2018, p. 74), illustrating the complex relationships between (i) violent conflicts and its potential drivers, (ii) migration and displacement and (iii) water-related impacts and climate change. In this report, we try to find a hierarchy in drivers: from drivers that show direct and intermediate relationships to violence and conflict, to those that are more fundamental in nature.

1.3 Aim of the study and outline of Parts I and II

The aim of this study is fivefold:

1. To give an overview of available human security indicators and frameworks, on an aggregated country basis. Special attention is given to temporal and spatial coherence patterns and quality assurance of the databases. Indicator frameworks are important to identify countries with high security risks, leading to priorities for humanitarian help (e.g. the UN Central Emergency Fund). Another application, although not explicitly addressed in this study, is the monitoring of the Sustainable Development Goals as formulated by the United Nations (Figure 1.3 and the UN website).
2. To support the storylines of the project on water-related hotspots, in particular, the models used for mapping future water challenges (Ligtvoet et al., 2018), those used for linking water security threats to conflict (De Bruin et al., 2018), and related PBL activities under the Planetary Security Initiative (e.g. Ligtvoet et al., 2017).
3. To perform a comparative study of composite risk indicators focusing on security threats and conflicts.
4. To perform statistical analyses of conflict drivers as proposed in the related literature. Special attention is paid to water-related indicators: water availability, water-related disasters, sanitation, infrastructure and drylands. These analyses are not directed towards the *prediction* of conflict outbreaks such as described by Cederman and Weidman (2017), but are meant to identify those conflict drivers that show a direct, intermediate or more fundamental relationship to conflict indicators. We address three conflict indicators: (i) the Global Peace Index, (ii) the number of people displaced by conflicts, including refugees, and (iii) the number of people who died due to violence and conflict.
5. To evaluate findings. Are statistical inferences substantiated by the literature on conflict, human security and climate change? What have we learned?

The current report, Part I of this study, focuses on the database (aims 1, 2 and 3), including the reliability issues. Chapter 2 describes the leading institutions and their databases covering all aspects of human security, and Chapter 3 discusses the composite indicator frameworks based on these databases. Chapter 4 addresses the temporal and spatial dependencies, and Chapters 5 and 6 describe the quality of composite indicators.

Part II of this study is presented in a report entitled 'Statistical inferences using machine learning techniques' (separate publication). It provides statistical analyses (aims 4 and 5), an overview of conflict drivers given in the literature, and derives three indicators for the intensity of conflict and violence, followed by a description of the statistical methodology used. Those three indicators serve as dependent variables in the statistical analyses. Figure 1.4 below gives an overview of the drivers chosen. These drivers are discussed and non-linear relationships are studied, applying a machine learning technique, called Regression Trees.

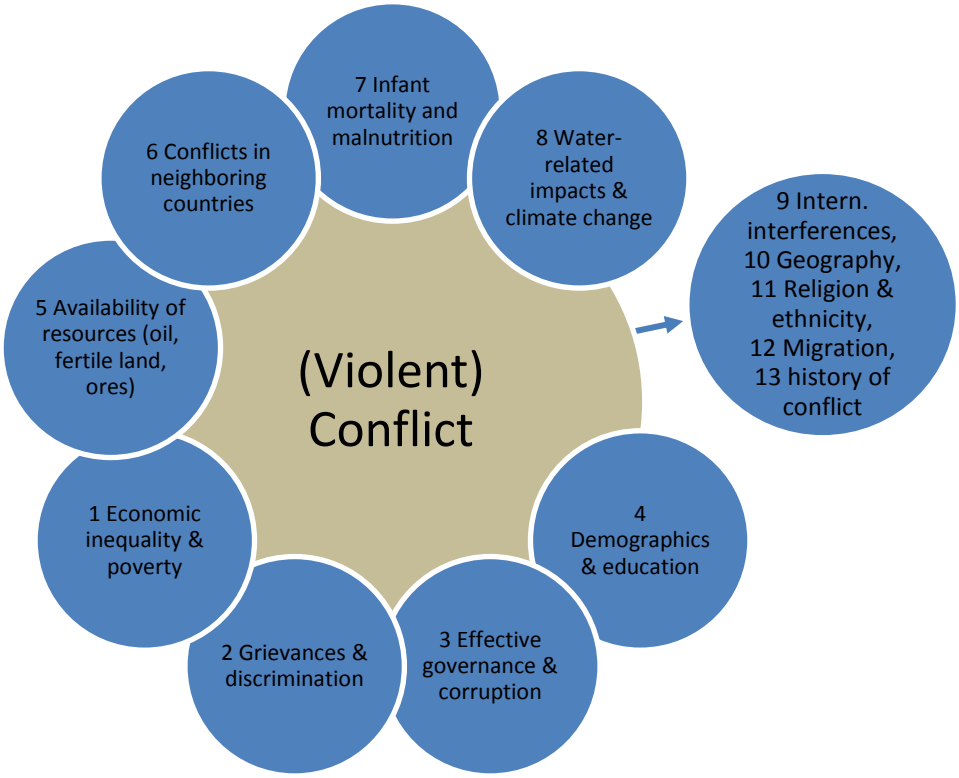


Figure 1.4 Overview of the conflict drivers addressed in Part II of this study. This 'driver carrousel' is a more detailed version of that shown in the lower left part of Figure 1.3. Factors (1) through (8) are used in a non-linear statistical context by use of so-called Regression Trees. Factors (9) through (13) are treated separately.

2 Human security indicators, based on country statistics

2.1 National-based indicators: pros and cons

Throughout this report, we use indicators and composite indicators based on *country statistics*. This choice has the important advantage of having numerous indicators available—often publicly—for human security and conflict studies. A second advantage is the global scope of data. Most indicators are available for around 190 countries in the world (or fewer countries, when those with small populations are left out).

Therefore, this study does not suffer from the so-called 'streetlight effect', as described in a recent study by Adams et al. (2018, plus discussions), who argue that claims regarding climate-conflict links are overstated because of sampling bias. This sampling bias comes from analysing only country or regional data for which climate and/or conflicts are *extreme* and disregarding other regions that are more 'in the middle'. Since we treat all countries on all continents equally, this study circumvents such a bias.

However, choosing countries as the main scale unit has drawbacks too. The first drawback is illustrated in Figure 2.1. The world map is distorted since all countries are plotted on equal level, with identical areas. The map shows for example that, due to the large number of countries in Africa (55) and the small number of countries in North America (23) and South America (12), the African continent will be awarded more weight in the statistical analyses in Part II of this study, simply because 55 >> (12 + 23). The only exception here is if 'the number of people per country' is used as an explanatory variable in a statistical regression setting. This number is correlated with 'area', a variable not explicitly used in our analyses.

A second drawback of a national-based approach is that patterns of poverty, corruption or conflicts may play on local, subnational scales rather than on a national scale. This holds especially for intrastate conflicts (rebel and guerrilla groups), where local factors play a dominant role, such as easy access to exploitable resources (oil, mining, water), social inequality and corruption, and rough terrain (for hiding). Countries may contain regions with varying degrees of autonomy, and not only one type of political system or one official regime, at any given time. These aspects are studied in detail by Buhaug (2005, Chapters 5 and 6). Another approach, on subnational levels, is given by the Joint Research Centre (JRC) in its INFORM index for risk management (see Figure 2.2).

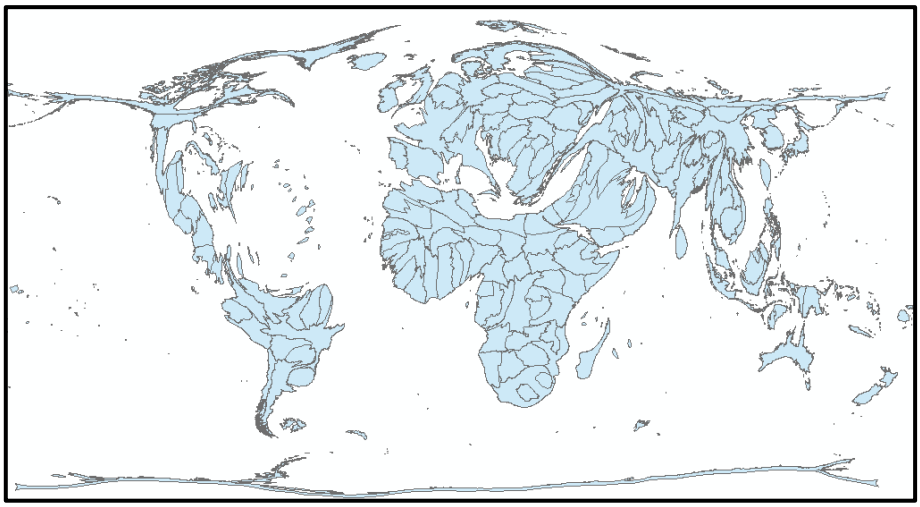


Figure 2.1 The traditional world map is distorted, this to symbolise that all countries are treated as equally important in statistical analyses (all countries are given equal areas). For example, countries in Africa are awarded more weight in the analyses than those in North and South America (55 countries and 35 countries, resp.).

In contrast, we use countries as whole entities. One argument — apart from the widespread availability of national-scale statistics, and the absence of local quality data — is that we do not aim to *predict* the onset and/or duration of any conflict, be it intrastate or interstate. We aim to quantify the peacefulness or non-peacefulness of countries as a whole, and to find indicators that show direct or more fundamental relationships to the level of violence and conflicts.

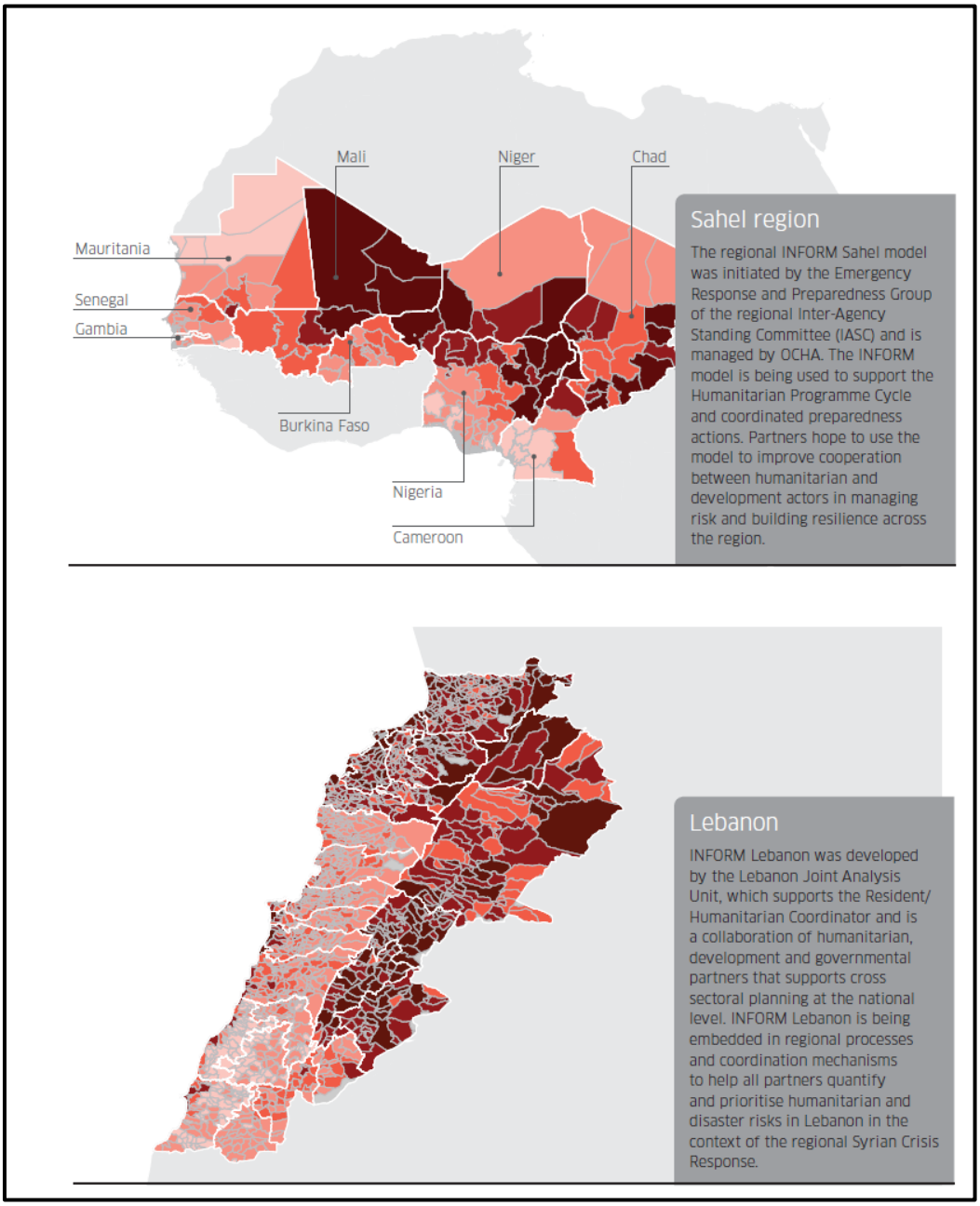


Figure 2.2 The INFORM index for risk management allows for subnational analyses. See report here.

2.2 Databases

2.2.1 CRED and Munich Re: disaster databases

In 1988, the Centre for Research on the Epidemiology of Disasters (CRED) launched the Emergency Events Database (EM-DAT). EM-DAT was created with the initial support of the World Health Organization (WHO) and the Belgian Government.

The main objective of the database is to serve the purposes of humanitarian action at national and international levels. The initiative aims to rationalise decision making for disaster preparedness, as well as to provide an objective base for vulnerability assessment and priority setting.

EM-DAT contains essential core data on the occurrence and effects of over 22,000 mass disasters in the world from 1900 to the present day. The database is compiled from various sources, including UN organisations, non-governmental organisations, insurance companies, research institutes and news services.

There are a great number of publications that base their analyses on data from EM-DAT. We refer to the EM-DAT website: http://www.emdat.be/publications . PBL publications based on EM-DAT are Visser et al. (2012) and Visser et al. (2014).

The CRED database comprises eight categories of disasters:

1. Hydrological hazards. These are coastal, river and flash floods (or, more generally, hazards caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater).
2. Climatological hazards. These are droughts and heat waves (or, more generally, hazards caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability).
3. Meteorological hazards. These are storms and cyclones (or, more generally, hazards caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from minutes to days).
4. Geophysical hazards. These are earthquakes and tsunamis (or, more generally, hazards originating from solid earth. This term is used interchangeably with the term geological hazard).
5. Biological hazards. These comprise all forms of epidemics (or, more generally, hazards caused by the exposure to living organisms and their toxic substances—such as venom, mould—or vector-borne diseases that they may carry. Examples are venomous wildlife and insects, poisonous plants, and mosquitoes carrying disease-causing agents such as parasites, bacteria, or viruses, such as malaria).
6. Technological hazards. These are technological disasters such transportation accidents or industrial explosions.
7. Complex hazards. Complex disasters are major famine situations for which drought was not the main causal factor.
8. Extra-terrestrial hazards. This category covers hazards caused by asteroids, meteoroids and comets. The database contains only one such a disaster.

Categories 1, 2 and 3 are denoted in this report as 'weather-related', categories 1, 2 and 4 (tsunamis only) as 'water-related'. Furthermore, we denote categories 4 to 8 as 'non-weather-related disasters' (although categories 5 and 7 have some relation to weather conditions).

The database consists of five impact indices: (i) people killed, (ii) people injured, (iii) total people affected, (iv) people becoming homeless and (v) direct economic damage. We note that global time series for economic damage and total people affected are shown in Figure 4.2A. Idem for total people killed and the number of reported disasters in Figure 4.2B.

For the *Planetary Security Initiative,* we downloaded the full data set (1900-2015), which contains all disaster categories, all impacts and all countries in the world. Since data before 1980 are unreliable, our data start in 1980 (Visser et al., 2012). Examples are given in Figure 2.3A.

Disaster data from CRED are open access. However, other data sets exist as well, be it on a commercial basis. We name Munich Re and Swiss Re. As for Munich Re, data cannot be approached directly, but summary statistics and global maps are available from their website. See for example Figures 2.3B and 23C, and the NatCatSERVICE website. Important publications are Topics Geo 2016 and Topics Geo 2017, available from the same website.

We use data from Munich Re in Section 5.3 and Figure 5.3 to show how disaster data from CRED and Munich Re relate. An example for the year 2015 is given in Figure 2.3B. Next to that the Munich Re website allows for interactive plotting of four disaster categories where the period can be chosen between 1980 and 2016. Figure 2.3C gives an example of all meteorological, hydrological and climatological events that occurred on a global scale over the 1980–2016 period.

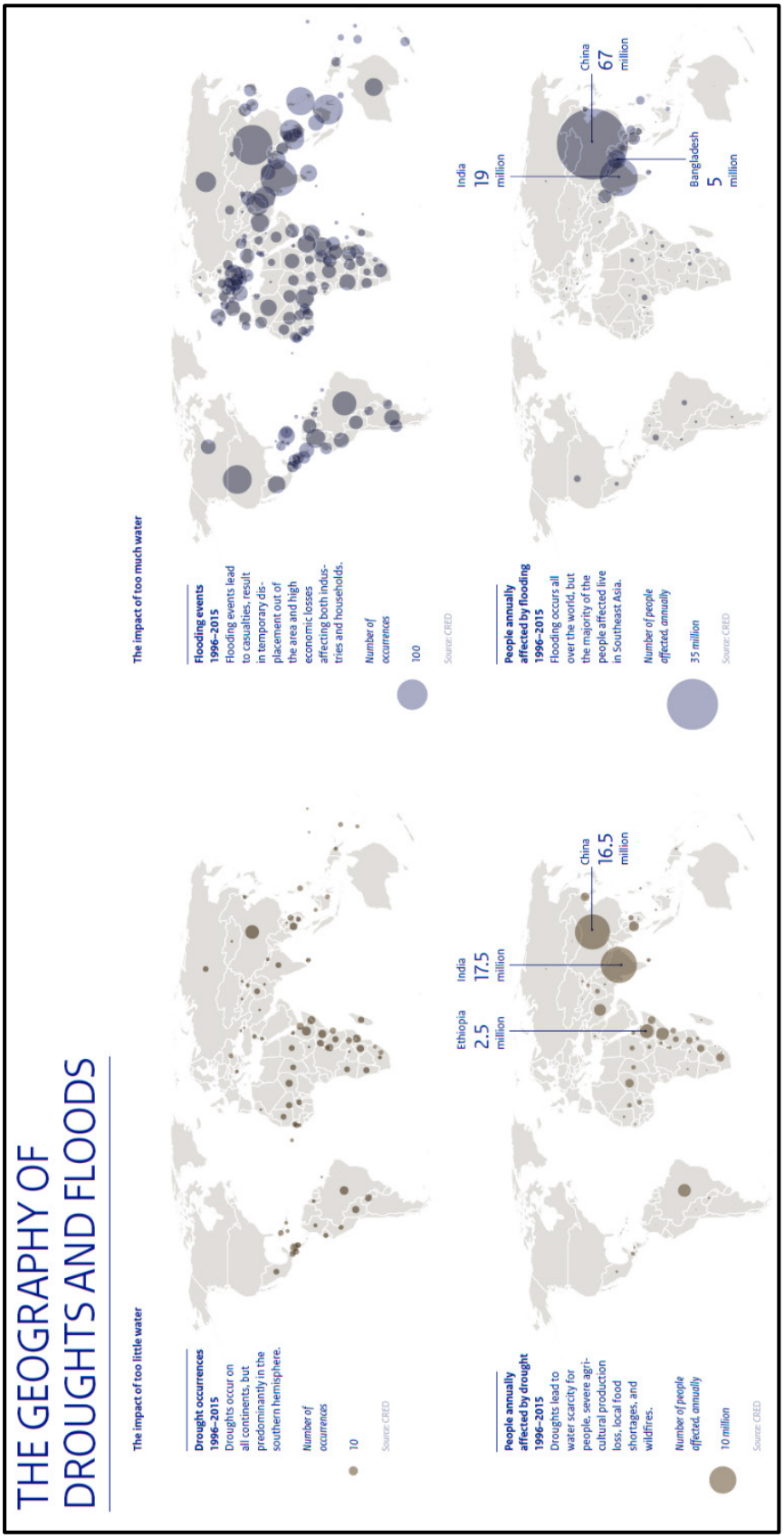


Figure 2.3A Examples of global drought impacts (lower left panels) and global flood impacts (upper right panels). Data are taken from the CRED Emergency Event Database EM-DAT and averaged over the 1996–2015 period. Graph taken from Ligtvoet et al. (2018).

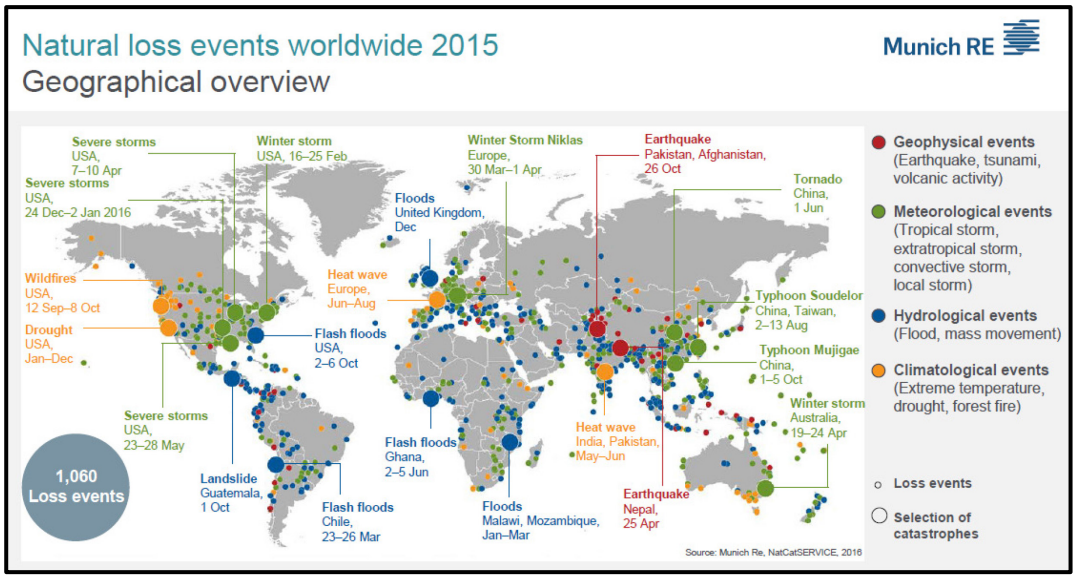


Figure 2.3B Natural disasters for the year 2015. Disasters are categorised into four groups: geophysical (red), meteorological (green), hydrological (blue) and climatological (orange). Source: Munich Re.

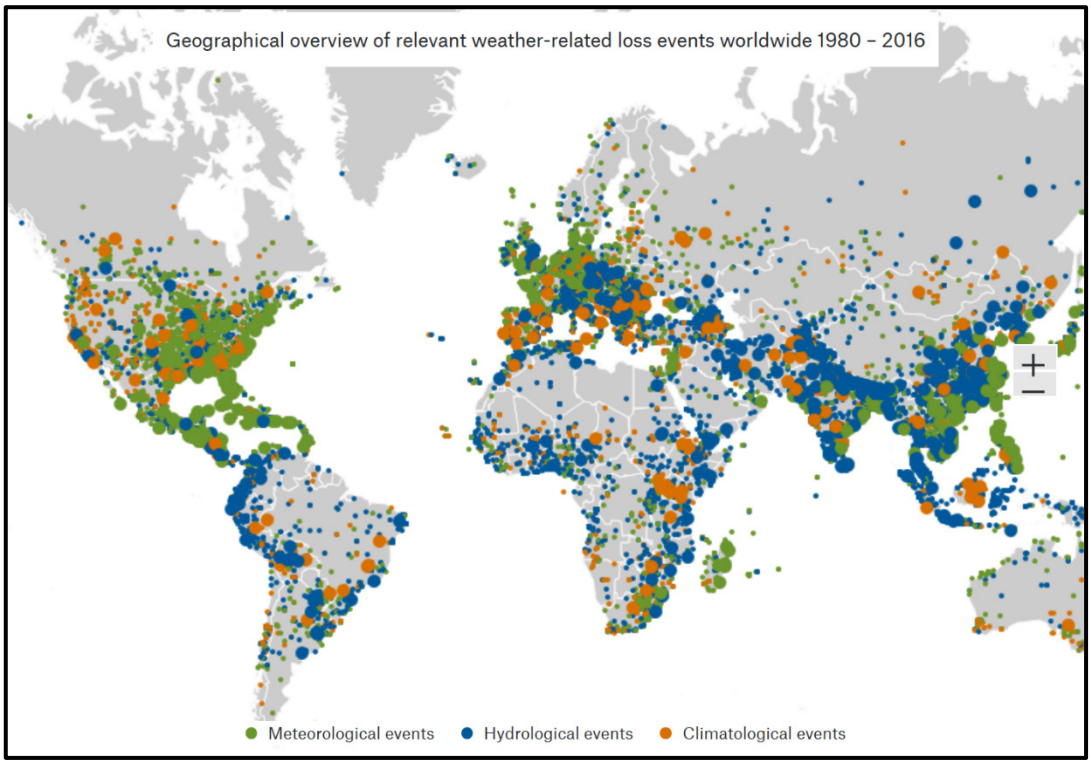


Figure 2.3C Weather-related disasters in the 1980–2016 period. Disasters are given in three categories: meteorological (green), hydrological (blue) and climatological (orange). This graph is made by an interactive tool where averaging period and type of disasters can be varied. Source: Munich Re.

2.2.2 FAO: food- and water-related issues

The Food and Agriculture Organization of the United Nations (FAO) is the global organisation for food and agriculture founded in 1943 and funded by the United Nations (UN). The main aim of this globally leading organisation is the achievement of food security for all, including the present and future sustainable management of resources and economic and social progress. The FAO is active, all around the world, in food security and distribution projects and performs studies on food security, including an annual report about the state of food security and nutrition in the world.

The FAO developed a set of indicators aiming to capture various aspects of food (in)security. The indicators are classified along four dimensions of food security; availability, access, utilisation and stability (Table 2.1). The database brings together indicators from among others the FAO, the World Health Organization (WHO), the World Bank (WB) and UNICEF. The indicators have been chosen based on expert judgement and the availability of data with sufficient coverage.

Table 2.1 Example of food indicators made available by FAO. See the FAO website .

Type of indicator	Source	Coverage
Availability		
Average dietary energy supply adequacy	FAO	1990-2016
Average value of food production	FAO	1990-2013
Share of dietary energy supply derived from cereals, roots and tubers	FAO	1990-2011
Average protein supply	FAO	1990-2011
Average supply of protein of animal origin	FAO	1990-2011
Access		
Percent of paved roads over total roads	WB	1990-2011
Road density	International Road Federation, World Road Statistics and electronic	1990-2011
Rail lines density	WB	1990-2012
Gross domestic product per capita (in purchasing power equivalent)	WB	1990-2013
Domestic food price index	FAO/ILO/WB	2000-2014
Prevalence of undernourishment	FAO	1990-2016
Share of food expenditure of the poor	FAO	partial
Depth of the food deficit	FAO	1990-2016
Stability		
Cereal import dependency ratio	FAO	1990-2011
Percent of arable land equipped for irrigation	FAO	1990-2012

2.2.3 World Bank Group: economic development

The World Bank Group is a family of five international organisations that make leveraged loans to developing countries. It is the largest development bank in the world and is an observer at the United Nations Development Group. The bank is based in Washington, D.C. and provided around USD 61 billion in loans and assistance to developing and transition countries in the year 2014. The bank's mission statement is to achieve the twin goals of ending extreme poverty and building shared prosperity. Total lending, as of 2015, over the last 10 years through Development Policy Financing, was approximately USD 117 billion.

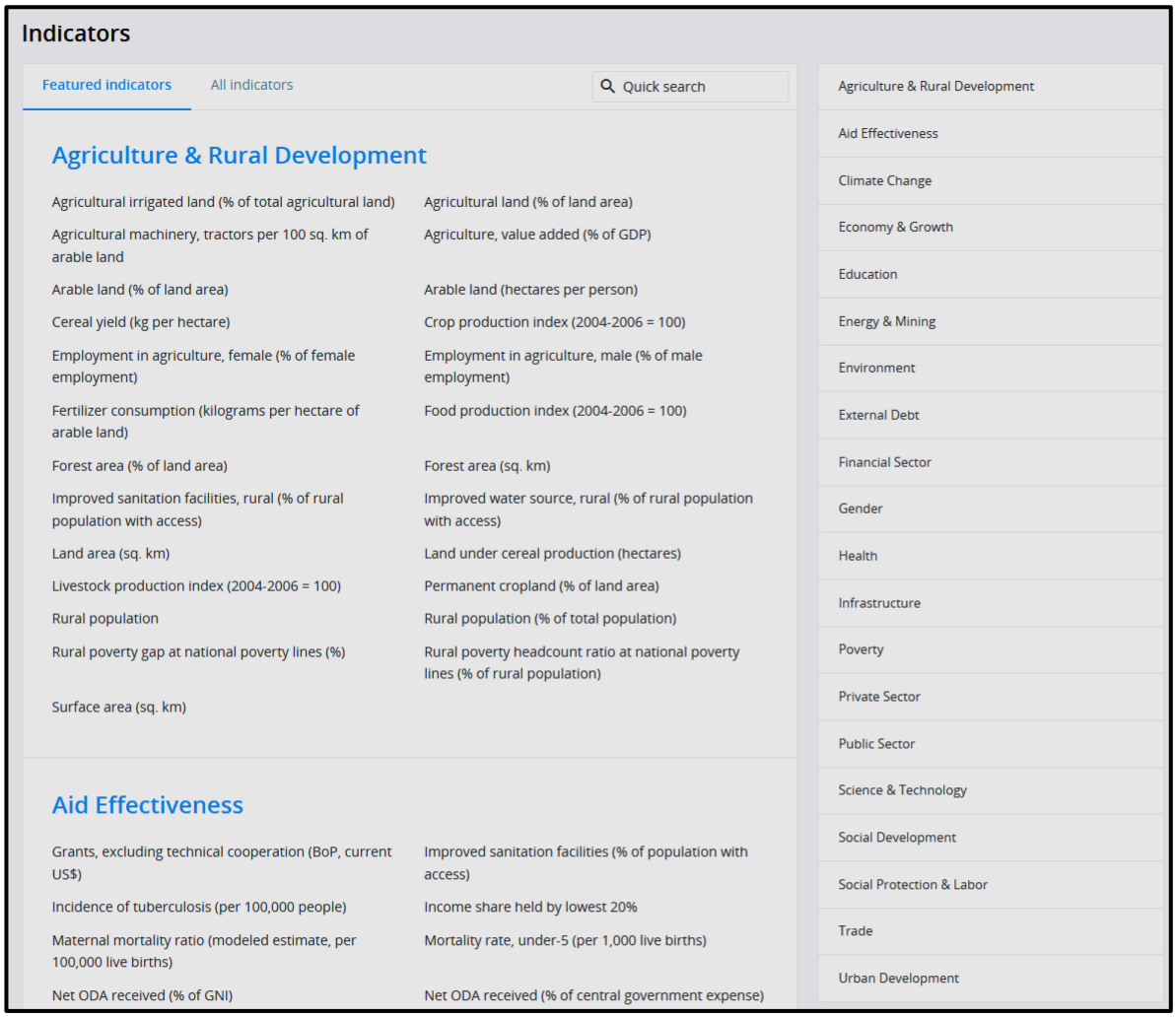
Its five organisations are the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC), the Multilateral Investment Guarantee Agency (MIGA) and the International Centre for Settlement of Investment Disputes (ICSID). The first two are sometimes collectively (and confusingly) referred to as the World Bank.

The World Bank's (IBRD and IDA) activities are focused on developing countries, in fields such as human development (e.g. education, health), agriculture and rural development (e.g. irrigation and rural services), environmental protection (e.g. pollution reduction, establishing and enforcing regulations), infrastructure (e.g. roads, urban regeneration, and electricity), large industrial construction projects, and governance (e.g. anti-corruption, legal institutions development). The IBRD and IDA provide loans at preferential rates to member countries, as well as grants to the poorest countries. Loans or grants for specific projects are often linked to wider policy changes in the sector or the country's economy as a whole.

The World Bank Group is one of the most powerful international organisations. The organisation has often been criticised for the dominant influence of the United States (Wade, 2002), and not taking local cultures, rights and needs into account (Sarfaty, 2017).

The World Bank Group has on open access policy on data and presents a number of development indicators on a global basis, along with tables, graph facilities and metadata. Data are on country basis and often start in the year 1960. See Table 2.2.

Table 2.2 The World Bank presents a wide set of global development indicators [in open access.]



2.2.4 Transparency International and World Bank: corruption and governance

The indicator that is used for governance in Part II of this study is a composite indicator compiled using the Corruption Perceptions Index by Transparency International (Transparency International, 2018) and Governance Effectiveness part of the worldwide governance indicators developed by the World Bank (Kaufman and Kraay, 2015). The rationale of this choice is given in Part II. The underlying indicators are described here.

Governance is a concept defined in many different ways. The definition followed by the World Bank for their *world governance indicators* is as follows (Kaufman and Kraay, 2015):

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

Transparency International – Corruption Perception Index
Transparency International has been funded in 1993. Today, the organisation is present in more than 100 countries, advocating against the abuse of public office for private gain. Transparency International aims to be politically non-partisan and is committed to advancing accountability, integrity and transparency worldwide. The organisation is funded by government, multilateral institutions, foundations, the private sector and private citizens.

Every year, the Corruption Perceptions Index (CPI) is published, which ranks 180 countries and territories by their perceived levels of public sector corruption according to experts and business people. The CPI scores and ranks countries based on how corrupt a country's public sector is perceived to be. It is a composite index, a combination of surveys and assessments of corruption, collected by a variety of reputable institutions such as Freedom House. Robustness checks were performed by the JRC in 2012 (Saisana and Saltelli, 2012).

World Governance Indicators
The World Governance Indicators (WGI) project reports aggregate and individual governance indicators for 200 countries and territories over the 1996–2016 period. The set of worldwide governance indicators comprises the following six dimensions (indicators):

- Voice and Accountability (VA)
- Political stability and Absence of violence (PA)
- Government Effectiveness (GE)
- Regulatory Quality (RQ)
- Rule of Law (RL)
- Control of Corruption (CC)

For the JRC governance composite the indicator 'Government Effectiveness' was chosen. It reflects the perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Data can be downloaded or shown in tables and graphs such as shown in Figure 2.4.

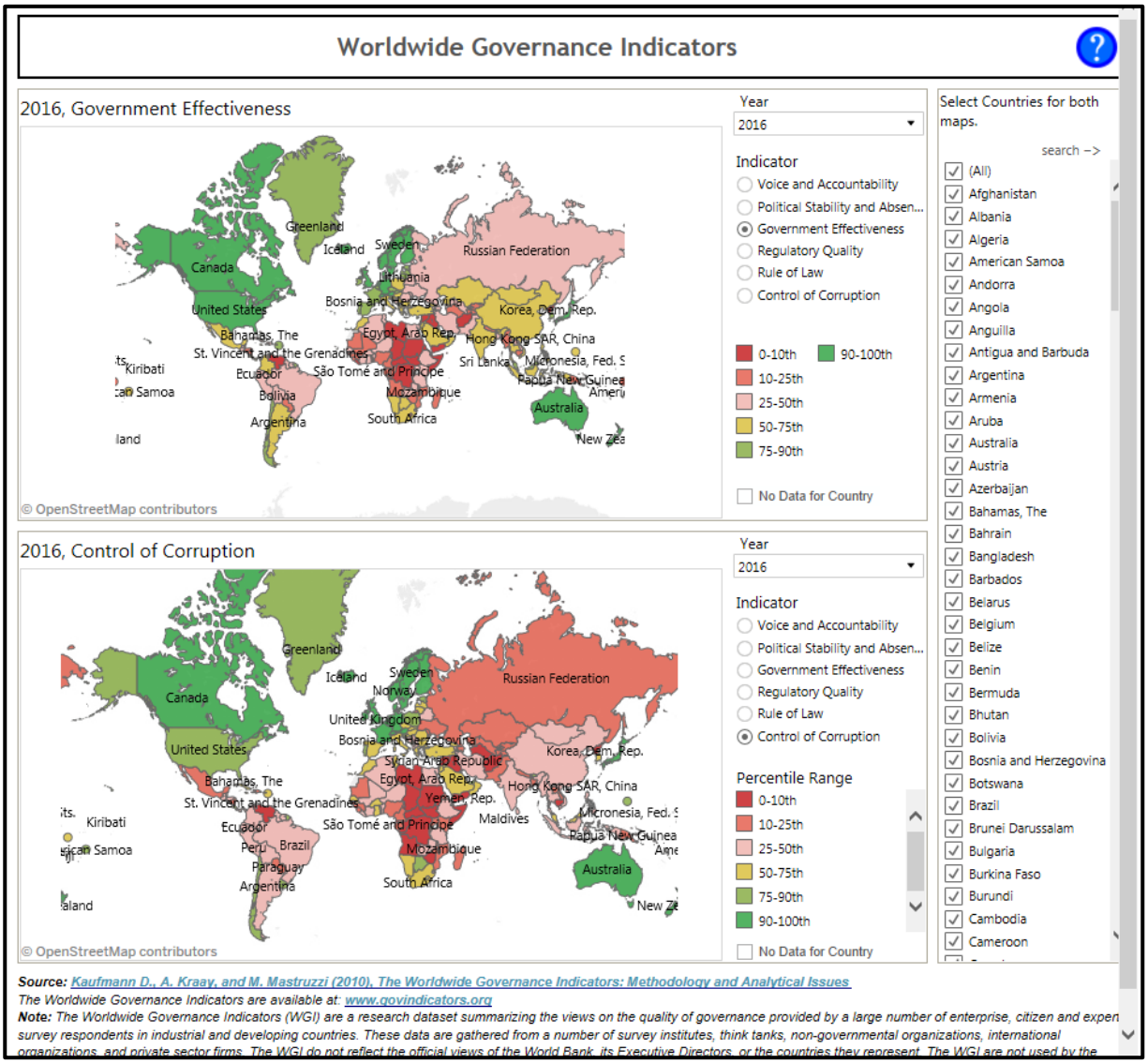


Figure 2.4 Two governance indicators on a global scale for the year 2016. Data are taken from the World Bank. This site allows for interactive plotting of the six governance dimensions.

We note that governance should not be interpreted as the level of democracy of countries. An indicator for the latter is the Polity score. Polity scores range from -10 up to +10, where values from -10 to -6 point to autocracies, -5 up to +5 to anocracies, and values from 6 to 10 to democracies (systemicpeace.org/polity).

2.2.5 United Nations: human development and population dynamics

The United Nations Development Programme (UN-DP) is the UN body governing, promoting, implementing and assessing the sustainable development goals (SDGs, Figure 1.2), defining the global 2030 agenda. The UN-DP also monitors human development on a country level: first published in 1990 and annually since then. The Human Development Reports have introduced a new approach for human well-being, an approach beyond economic development. The Human Development Report focuses on people, their functioning, capabilities and their voice and autonomy (UN-DP, 2016). See Figure 2.5A.

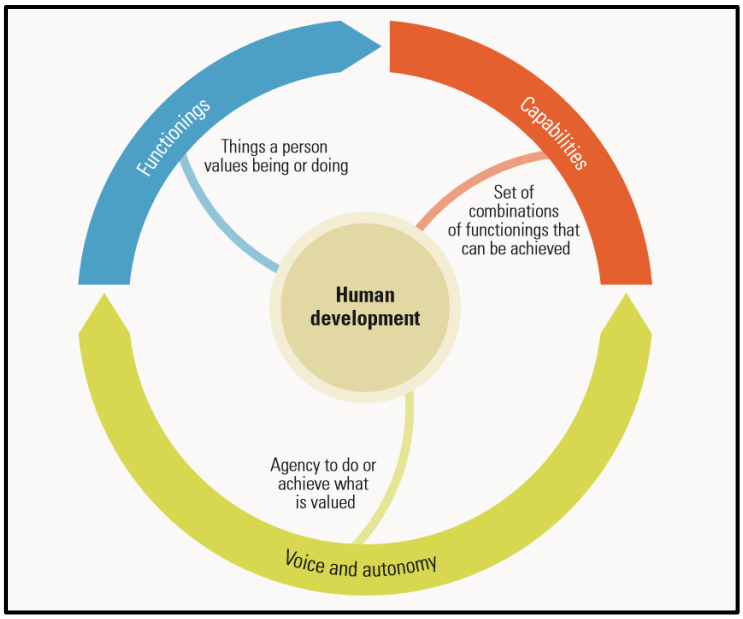


Figure 2.5A UN-DP theoretical approach towards Human Development.

Human development is quantified based on five composite indicators. The Human Development Index (HDI) integrates three basic dimensions of human development; life expectance at birth, schooling (mean years and expected years) and the gross national income per capita. The second composite indicator, the inequality-adjusted HDI, discounts the HDI according to the extent of inequality. The Gender Development Index compares female and male HDI values; the Gender Development Index analyses women's empowerment. The last composite indicator of human development is the Multinational Poverty Index, which measures assessing variables that go beyond poverty measured in monetary terms, such as access to public services and certain types of housing.

The data for the UN-DP reports come from a range of UN organisations (including the FAO, WHO, UNICEF and UN Women), as well as from CRED EM-DAT, EUROSTAT, Gallop, ICF Macro Demographic & Health Services, the Syrian Centre for Policy Research, Luxembourg Income Study, Inter-Parliamentary Union, International Monetary Fund, the World Bank, International Labour Organization, Internal Displacement Monitoring Centre and the International Centre for Prison Studies. See Figure 2.5B for an example.

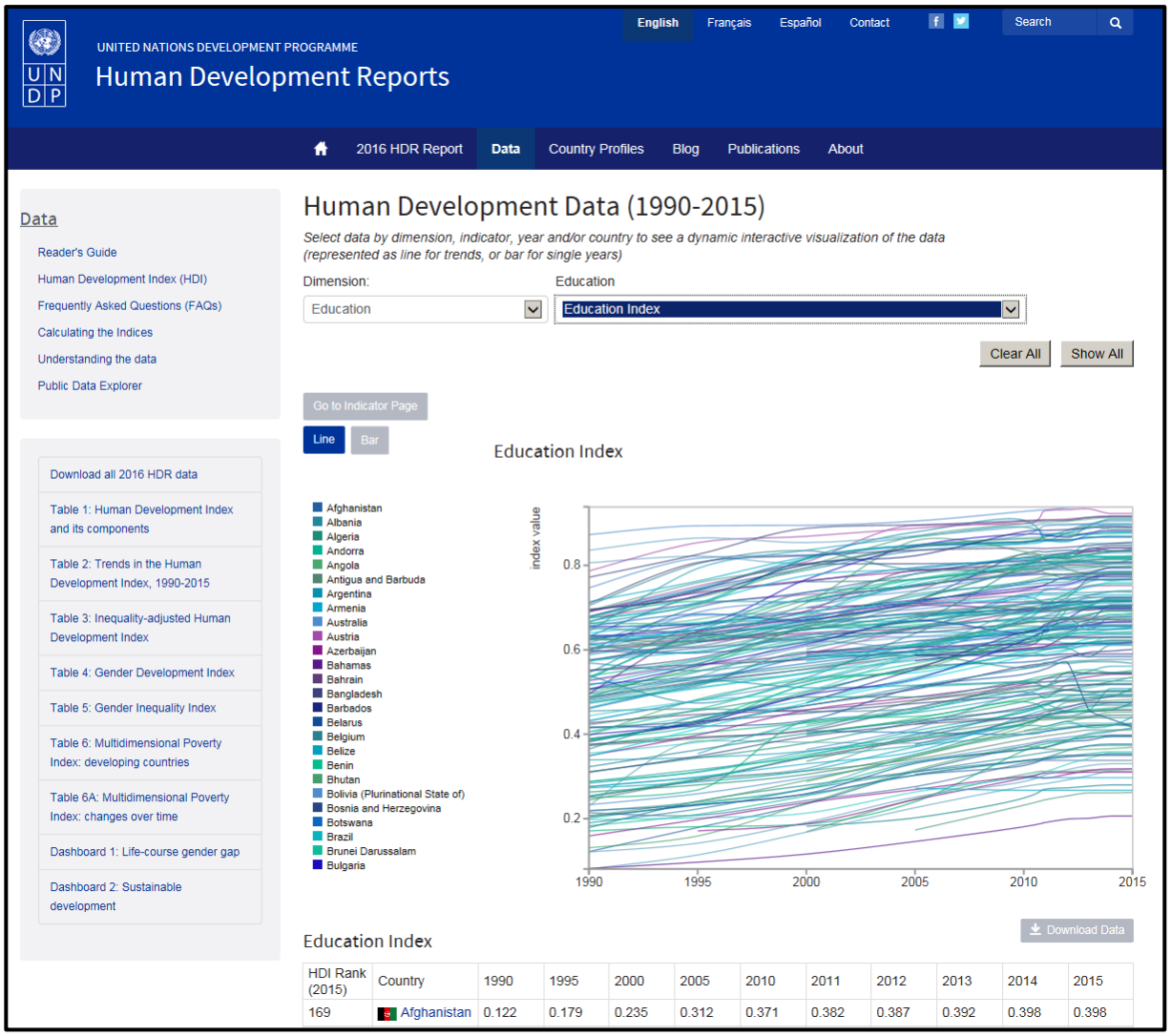


Figure 2.5B Data from the UN Development reports can be downloaded from here: http://hdr.undp.org/en/data# . The site allows for interactive plotting of data.

Leading population data are supplied by the United Nations population division and published as World Population Prospects 2017. The 2017 Revision of World Population Prospects is the 25th round of official United Nations population estimates and projections that have been prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.

The main results are presented in a series of Excel files, displaying key demographic indicators for each development group, income group, region, sub-region and country or area, for selected periods or dates within the 1950–2100 period. Data can be downloaded here. Figure 2.5C gives an example of annual population growth, for the year 2015.

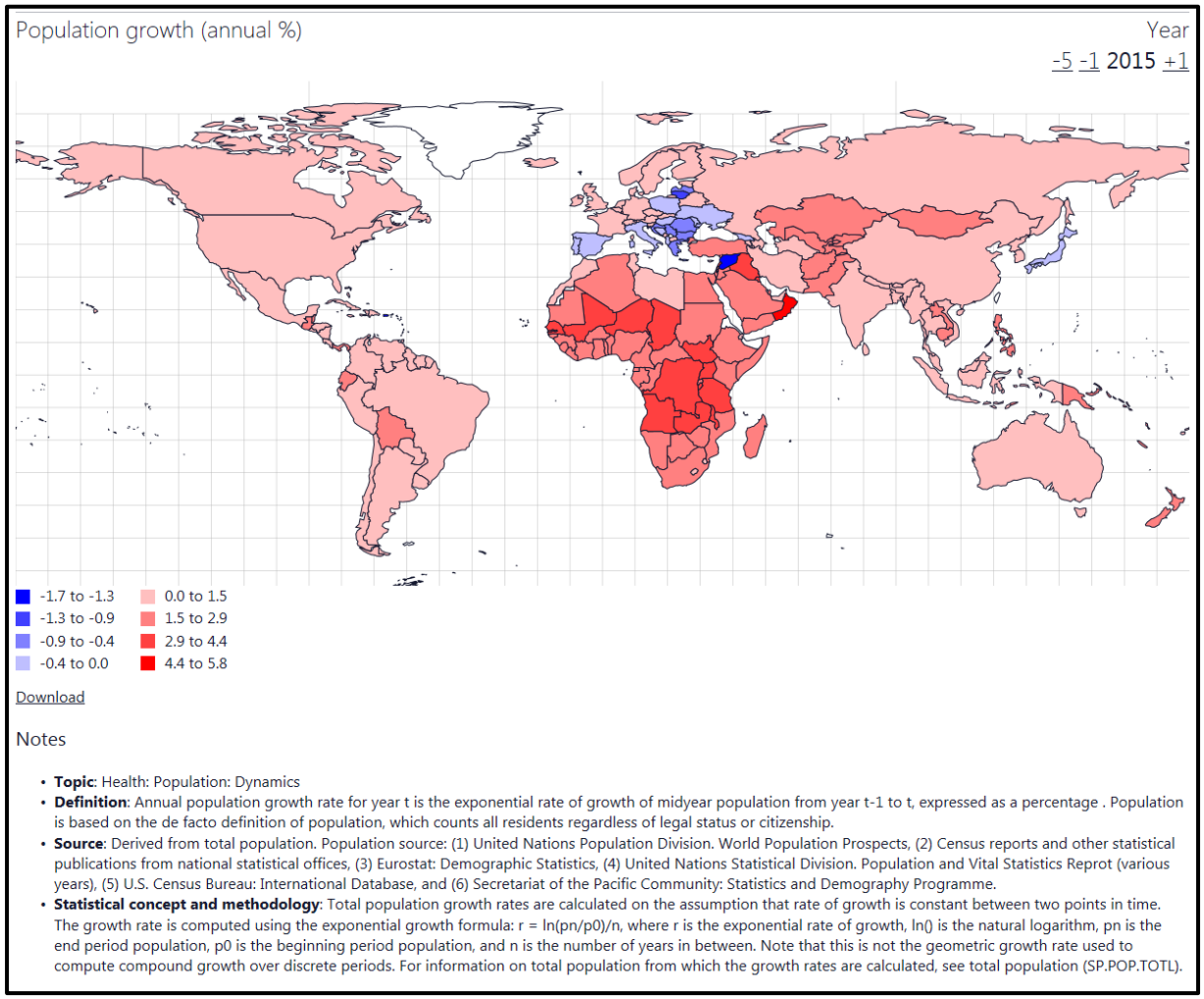


Figure 2.5C National-based population growth for the year 2015. Data are in %. Source: https://www.populationpyramid.net/hnp/population-growth/2015/

Another characteristic of population, its age structure, has been identified by several studies as a risk factor for conflict. Countries that have a large youth population relative to the older generations (also called a 'youth bulge'), are found to face higher risks of conflict, especially under conditions of economic stagnation (Urdal, 2011; LaGraffe, 2012; Hegre et al., 2013). Youth bulges have been linked to rioting and revolution in societies with little economic prospects for young people. A study by Nordas and Davenport (2013) found that large youth cohorts increase the repression of state authorities, since the younger population is more likely to challenge authority.

Figure 2.5D gives an example of such 'age pyramids', for China, Nigeria, the Netherlands and Syria. Youth bulge indicators directly follow from these age pyramids, i.e. a relatively large percentage of young people in the age group 15 to 24.

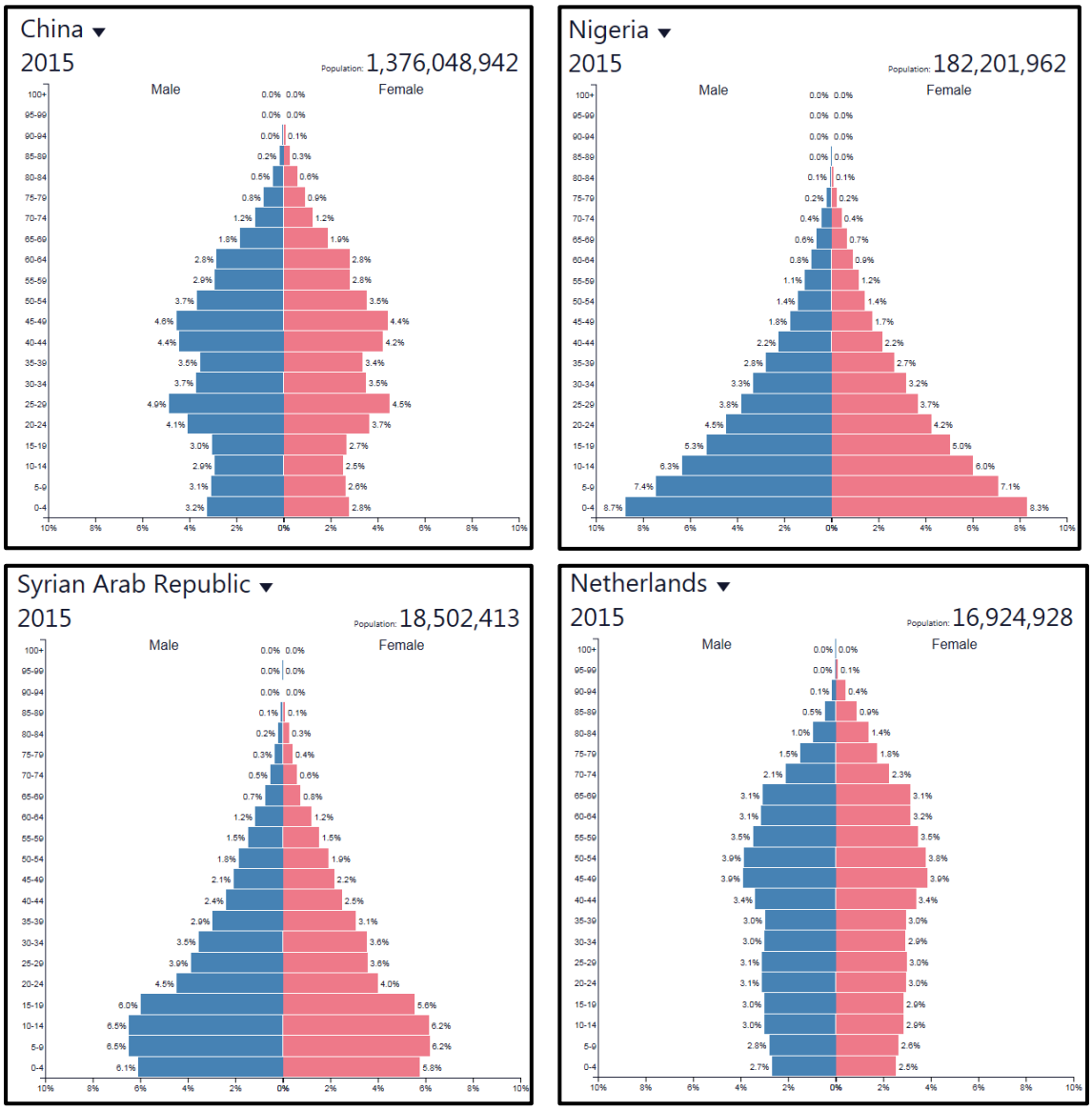


Figure 2.5D Four age pyramids with quite different shapes. Data can be found here. The percentage of population younger than 20 years of age is around 23% for China, 54% for Nigeria, 49% for Syria and 23% for the Netherlands.

2.2.6 Institute for Economics & Peace: conflict-related indicators

The institute for Economics & Peace is a non-profit and independent think tank founded in 2007 and funded by Australian IT entrepreneur and philanthropist Steve Killelea. The institute focusses on developing metrics to analyse peace and uncovering the relationships between business, peace and prosperity. IEP has four areas of key research: measuring peace, positive peace[1], the economics of peace and risks. The main product of the institute is their annual Global Peace Index (GPI), ranking the relative peacefulness of 162 of the world's nation states.

The GPI is based on 23 indicators in three overarching categories: ongoing domestic and international violence; societal safety and security and militarisation. See Table 2.3. The indicators have been selected and weighted by experts from all around the world and are sourced from the latest available data, from a wide range of international institutes: the Uppsala Conflict Data Program (UCDP), International Institute for Strategic Studies (IISS), qualitative assessments by The Economist Intelligence Unit (nine indicators), qualitative assessments by Amnesty International and the US State Department annual reports, Global Terrorism Index, World Prison Brief, Institute for Criminal Policy Research at Birkbeck, United Nations Office, The Military Balance, IISS on Drugs and Crime (UNODC), surveys on Crime Trends and the Operations of Criminal Justice Systems (CTS), Stockholm International Peace Research Institute (SIPRI) and the UN Register of Conventional Arms.

[1] Positive peace goes beyond just the absence of violence: 'Positive Peace represents the capacity for a society to meet the needs of its citizens, reduce the number of grievances that arise and resolve remaining disagreements without the use of violence.' (IEP, 2016, p. 80).

Table 2.3 Indicators underlying the Global Peace Index. These indicators are available for 163 countries. See Appendices A and B in IEP (2017).

TABLE 29 INDICATOR WEIGHTS
Internal Peace 60% / External Peace 40%

INTERNAL PEACE (WEIGHT 1 TO 5)	
Perceptions of criminality	3
Security officers and police rate	3
Homicide rate	4
Incarceration rate	3
Access to small arms	3
Intensity of internal conflict	5
Violent demonstrations	3
Violent crime	4
Political instability	4
Political Terror	4
Weapons imports	2
Terrorism impact	2
Deaths from internal conflict	5
Internal conflicts fought	2.56
EXTERNAL PEACE (WEIGHT 1 TO 5)	
Military expenditure (% GDP)	2
Armed services personnel rate	2
UN peacekeeping funding	2
Nuclear and heavy weapons capabilities	3
Weapons exports	3
Refugees and IDPs	4
Neighbouring countries relations	5
Number, duration and role in external conflicts	2.28
Deaths from external conflict	5

2.2.7 Uppsala Conflict Data Program and UNODC: conflict- and violence-related deaths

The Uppsala Conflict Data Program (UCDP) is an online, open-source database keeping track of the state of armed conflict in the world. The UCDP has been established in the mid 1980s by the department of Peace and Conflict Research of the Uppsala University. The database is widely used and updated several times a year, containing information since 1946. The UCDP distinguishes three types of conflict: state-based, non-state violence and one-sided violence. The database also contains detailed information on armed conflict, peace agreements and other aspects of organised violence. The UCDP is mainly funded by external organisations: various research foundations and government organisations have supported the program, as well as the Bank of Sweden Tercentenary Foundation, the Swedish Research Council beside the Uppsala University.

The results of the UCDP are published in the annual report series *States in Armed Conflict* (1987–2012), in the SIPRI Yearbook since 1988, the Journal of Peace Research since 1993 and in the Human Security Reports since 2005. Numerous articles and databases make use of the UCDP Data Program. See Figure 2.6A

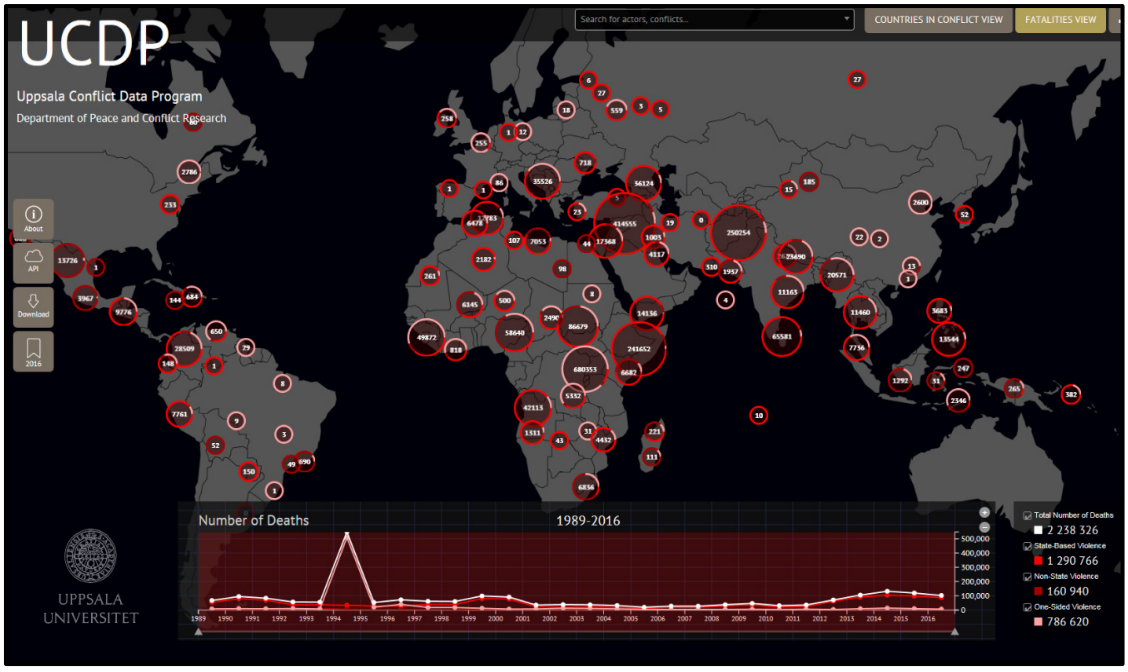


Figure 2.6A The website of the Uppsala Conflict Data Program (UCDP) gives interactive information on conflict-related deaths, divided into three categories: state-based violence, non-state violence and one-sided violence. Information is given on maps and as time series. Source: [the UCDP website .]

UCDP collects information about conflict via diverse sources. For each country, a specified set of sources is selected, including major newswires (Reuters, AFP, Xinhua, EFE) and BBC monitoring (local media). A second source is information from publications of academic

articles, case studies, NGO reports and books. When data is not clear or contradiction exist, regional experts are consulted.

For the present study we used three UCDP data sets on deaths from violent conflict, on a country basis: (i) deaths due to state-based conflicts, also denoted as 'battle-related deaths', (ii) deaths due to non-state violence and (iii) deaths due to one-sided violence. Sample period is 1989 to 2016, for all three databases. Definitions are as follows (taken from Melander, 2015):

- **State-based conflict** is armed conflict between two national governments (i.e., interstate conflict) such as the one between Ethiopia and Eritrea in 1998-2000, or between a government and rebel organisation (i.e., intrastate conflict) such as the conflict between the Government of Colombia and the Revolutionary Armed Forces of Colombia (FARC).
- **Non-state conflict** refers to armed conflict between two organised actors, neither of which is a nation state. Examples of non-state conflicts include the conflict between the Islamic State (IS) and the Kurdish Democratic Union Party (PYD) in Syria, as well as that between Hindus and Muslims in India.
- **One-sided violence** is when an organised actor (a nation state or some organised non-state actor) kills unarmed civilians, such as the violence committed by the government and associated militias in Rwanda in 1994, and the violence committed more recently, in Nigeria, by Jama'atu Ahlis Sunna Lidda'awati wal-Jihad, commonly known as Boko Haram.

In addition to these conflict-related databases, we downloaded a database on violence-related deaths compiled by the United Nations Office on Drugs and Crime (UNODC in short). The database contains intentional homicides on country basis. See Figure 2.6B for the relationship between homicides and the UCDP databases. Sample period is 2003–2015.

UNODC gives the following definition and limitation:

- **Intentional Homicide** means unlawful death purposefully inflicted on a person by another person. Data on intentional homicide should also include serious assault leading to death and death as a result of a terrorist attack. It should exclude attempted homicide, manslaughter, death due to legal intervention, justifiable homicide in self-defence and death due to armed conflict.
- When using the figures, any cross-national comparison should be conducted with caution, because there are differences in legal definitions of offences between countries, between methods of offence counting and recording, and between shares of criminal offences that are not reported to the police or remain undetected by law enforcement authorities.

Part II of this study uses homicides on a country basis and averaged over the years 2011–2015. If data are missing, the average is taken over the years where data are available.

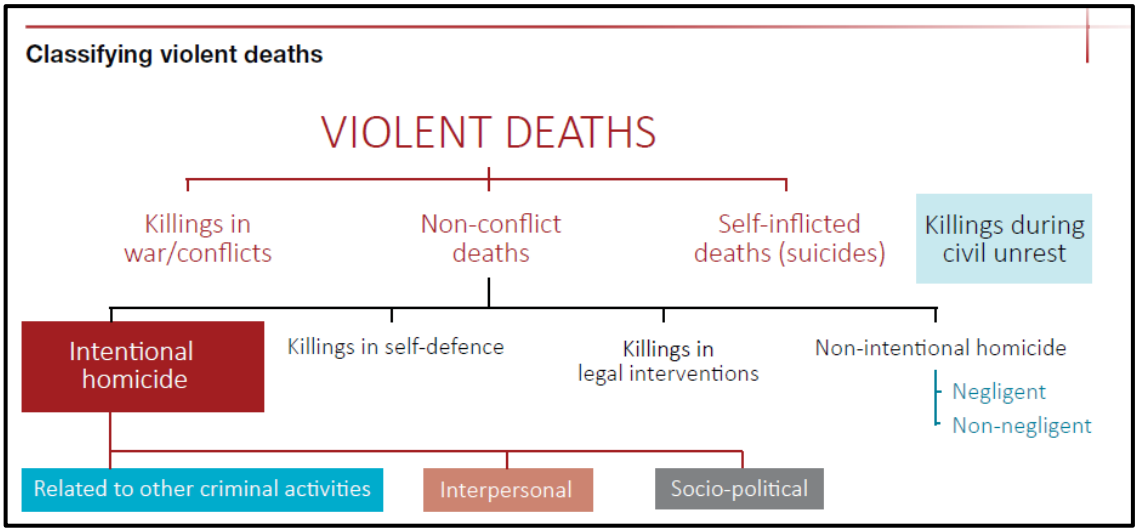


Figure 2.6B UNODC definitions of violent deaths. Data used here are for 'Intentional homicide'. Details are given on the UNODC website.

2.2.8 Sustainable Development Solutions Network: World Happiness

The UN Sustainable Development Solutions Network (SDSN) has been operating since 2012 under the auspices of the UN Secretary-General. Annual reports present country specific scores of happiness, based on among others income, work, community and governance, values and religion, as well as internal factors such as mental health, education, and gender and age.

SDSN mobilises global scientific and technological expertise to promote practical solutions for sustainable development, including the implementation of the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. SDSN aims to accelerate joint learning and promote integrated approaches that address the interconnected economic, social, and environmental challenges confronting the world. SDSN works closely with United Nations organisations, multilateral financing institutions, the private sector, and civil society.
Since 2012 SDSN publicises an annual report on global happiness (social well-being). See http://worldhappiness.report/ . For this report we download their happiness index for 115 countries.

2.2.9 IDMC, UNHCR, UN-DESA and IOM: IDPs, refugees and migrants

The Internal Displacement Monitoring Centre (IDMC) and the United National Refugee Agency (UNHCR) both keep track upon displacement. The UNHCR, created in 1950 during the aftermath of the Second World War, is the UN organisation protecting and assisting refugees around the world. With a budget of 7.7 billion, programmes supporting operations and emergency programmes are financed. The UNHCR is for 87% funded by governments and the European Union and collects her data about the global numbers of refugees, by registering the number of people and using biometrics to optimise numbers. The numbers are published annually in the UNHCR's Global Report. These reports include financial, regional, and thematic information about refugees and projects.

The IDMC is a non-profit organisation, set up in 1998, carrying out research on the drivers, patterns and impact of internal displacement resulting from conflict and violence, disasters and climate change, and development investments. The IDMC is funded by a range of government organisations and NGOs, including USAID, the European Commission and UNHCR. Data is collected by monitoring displacement situationally (when it comes to conflicts or to disaster-induced events). The IDCM uses data sources including government authorities, UN organisations, related global databases, NGOs and news media. Report are published annually, per country presenting the number of displaced people, distinguishing between new and existing displacements. A Displacement Data Exploration Tool can be found here: http://www.internal-displacement.org/database/displacement-data-exploration-tool. An example is given in Figure 2.7.

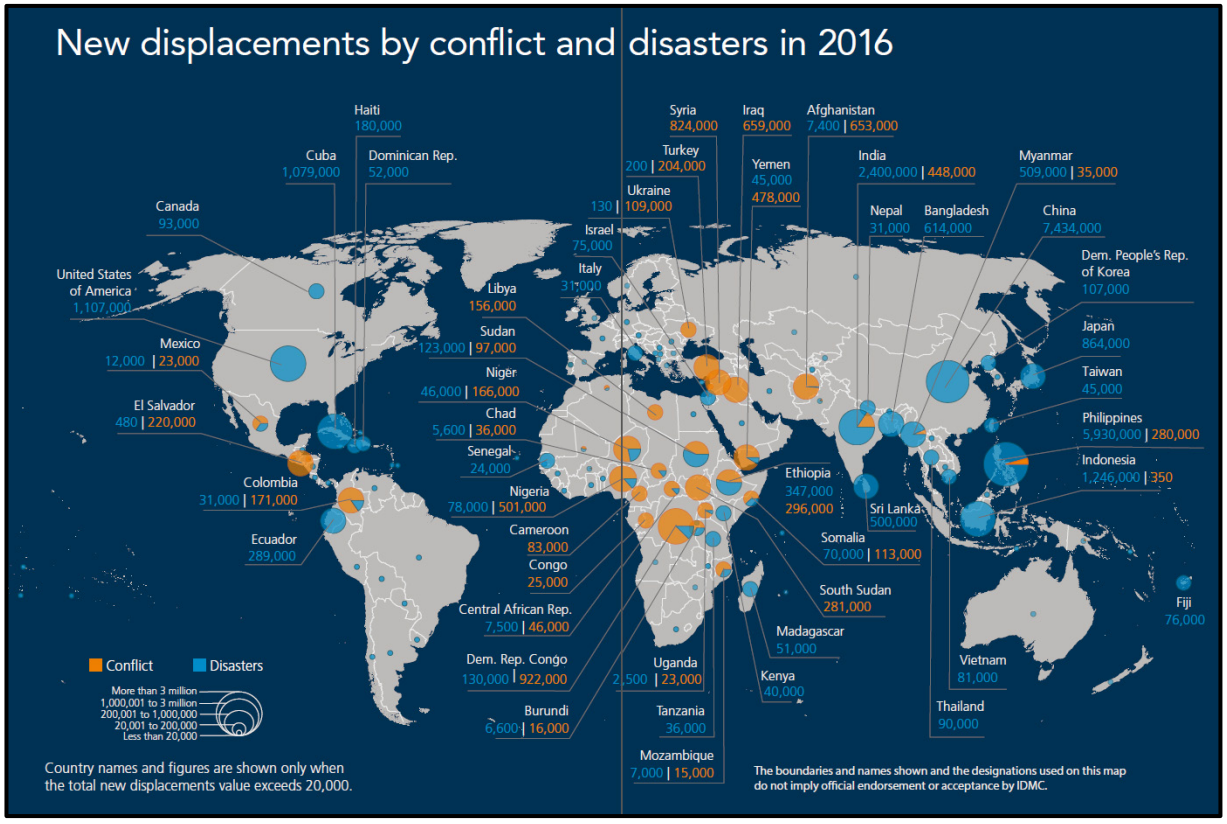


Figure 2.7 New displacements by conflicts (orange) and disasters (blue) for the year 2016.

The International Organization for Migration (IOM) was founded in 1951, out of the chaos and displacement of Western Europe following the Second World War. Mandated to help European governments to identify resettlement countries for the estimated 11 million people uprooted by the war, it arranged transport for nearly a million migrants during the 1950s. From its roots as an operational logistics organisation, it has broadened its scope to become the leading international organisation working with governments and civil society to advance the understanding of migration issues, encourage social and economic development through migration, and uphold the human dignity and well-being of migrants.

The broader scope of activities has been matched by rapid expansion from a relatively small organisation into one with an annual operating budget of an estimated USD 1.4 billion and some 9,000 staff working in over 150 countries, worldwide. IOM currently has 165 Member States and a further 8 states holding Observer status. Since 2000, IOM has been producing world migration reports. This World Migration Report 2018, the ninth in the world migration report series is meant to better contribute to increase the understanding of current and strategic migration issues throughout the world.

IOM defines migrants as any persons who are moving or have moved across an international border or within a nation state — away from their habitual place of residence — regardless of (1) these people's legal status, (2) whether the move was voluntary or involuntary, (3) what the reasons for the move were, or (4) the length of their stay.

We note that data for total internal migration in countries are difficult to find. Next to internal displacements due to natural disasters or conflicts, other (economic) drivers exist, leading to urbanisation trends in many countries. Urbanisation trends are estimated by the United Nations Population Fund (UNFPA) but overlap with other displacements.

Box 2.1 UNHCR definition of refugees and migrants

With more than 65 million people forcibly displaced, globally, and boat crossings of the Mediterranean Sea still regularly in the headlines, the terms 'refugee' and 'migrant' are frequently used interchangeably in both the media and public discourse. However, there is an important difference between the two.

Refugees are persons fleeing armed conflict or persecution. There were 21.3 million refugees worldwide, at the end of 2015. Their situation is often so perilous and intolerable that they cross national borders to seek safety in nearby countries, and thus become internationally recognised as 'refugees' with access to assistance from nation states, UNHCR, and other organisations. They are recognised as such precisely because it is too dangerous for them to return home, and they need sanctuary elsewhere. These are people for whom denial of asylum, potentially, has deadly consequences.

Refugees are defined in and protected under international law. The 1951 Refugee Convention and its 1967 Protocol, as well as other legal texts, such as the 1969 OAU Refugee Convention, remain the cornerstones of modern refugee protection. The legal principles they enshrine have permeated into countless other international, regional, and national laws and practices. The 1951 Convention defines who is a refugee and outlines the basic rights that nation states should afford refugees. One of the most fundamental principles laid down in international law is that refugees should not be expelled or returned to situations where their lives and freedom would be under threat.

Migrants choose to move, not because of a direct threat of persecution or death, but mainly to improve their lives by finding work, or in some cases for education, family reunion, or other reasons. Unlike refugees, who cannot safely return to their home country, migrants face no such impediment. If they would choose to return, they would continue to receive the protection of their national government.

For individual governments, this distinction is important. Countries deal with migrants under their own immigration laws and processes. Countries deal with refugees according to the norms of refugee protection and asylum that are defined in both national legislation and international law. Countries have specific responsibilities towards anyone seeking asylum within their territory or at their borders. UNHCR helps countries deal with their asylum and refugee protection responsibilities.

2.2.10 Joint Research Centre: basic indicators for human security and global risks

The Joint Research Centre (JRC) is the European Commission's science and knowledge centre. It was founded over 50 years ago and is currently located in five EU countries. All JRC data is fully accessible. One of the tools published by the JRC is the Global Conflict Risk Index (GCRI), an early warning system designed to provide policymakers with a global risk assessment, on a country level. This index shows the statistical risk of violent conflict in the next 1 to 4 years, based on 5 dimensions compiled of 24 indicators.

The five dimensions are centred around the domains of politics, security, society, economy, geography and environment. The 24 indicators come from open-source databases, such as those of UN organisations, UCDP, World Bank, FAO and the World Resources Institute (Collier, 2007; Smidt, 2016). The data were recently updated, up to the year 2017. See Table 2.4A.

Table 2.4A Overview of 24 indicators contained in the JRC Global Conflict Risk database.

Risk Area	Concept	Indicator	Source
Political	Regime type	Regime Type	CSP
		Lack of Democracy	CSP
	Regime performance	Government Effectiveness	World Bank
		Level of Repression	CIRI
		Empowerment Rights	PTS
Security	Current conflict situation	Recent Internal Conflict	HIIK; UCDP/PRIO
		Neighbouring with HVC	HIIK; UCDP/PRIO
	History of conflict	Years since HVC	HIIK; UCDP/PRIO
Social	Social cohesion and diversity	Corruption	World Bank
		Ethnic Power Change	ETH Zurich
		Ethnic compilation	ETH Zurich
		Transnational Ethnic Bonds	CIDCM
	Public security and health	Homicide Rate	UNODC
		Infant Mortality	UNICEF
Economy	Development and distribution	GDP per capita	World Bank
		Income inequality	World Bank
		Openness	World Bank
	Provisions and Employment	Food Security	FAO
		Unemployment	ILOSTAT
Geography and Environment	Geographic challenge	Water Stress	WRI
		Oil Production	World Bank
		Structural Constraints	BTI
	Demographics	Population Size	World Bank
		Youth Bulge	UNDESA

INFORM is another global, open-source risks assessment developed by the JRC, to indicate the level of humanitarian crises and disasters on a country scale. Table 2.4B shows the underlying structure of the composite indicators, combining hazards and exposure with vulnerability and cooping capacity on a country level. This tool is used for informed decision making, particularly by the European Commission. The components consist of data from, among others, the FAO, the HIIK conflict barometer, EM-DAT CRED, the World Bank and several UN organisations.

Table 2.4B Overview of 53 INFORM indicators and their composites. Indicators 19 and 20 are taken from the GCRI database shown in Table 2.4A.

N.	Name of core indicator	Position in the INFORM model		
1	Physical exposure to earthquake MMI VI (absolute)	Earthquake	Natural	Hazard & Exposure
2	Physical exposure to earthquake MMI VI (relative)			
3	Physical exposure to earthquake MMI VIII (absolute)			
4	Physical exposure to earthquake MMI VIII (relative)			
5	Physical exposure to tsunamis (absolute)	Tsunami		
6	Physical exposure to tsunamis (relative)			
7	Physical exposure to flood (absolute)	Flood		
8	Physical exposure to flood (relative)			
9	Physical exposure to surge from tropical cyclone (absolute)	Tropical Cyclone		
10	Physical exposure to surge from tropical cyclone (relative)			
11	Physical exposure to tropical cyclone of SS 1 (absolute)			
12	Physical exposure to tropical cyclone of SS 1 (relative)			
13	Physical exposure to tropical cyclone of SS 3 (absolute)			
14	Physical exposure to tropical cyclone of SS 3 (relative)			
15	People affected by droughts (absolute)	Drought		
16	People affected by droughts (relative)			
17	Frequency of Drought events			
18	Agriculture Drought probability			
19	GCRI Violent Internal Conflict probability	Projected Conflict Risk	Human	
20	GCRI High Violent Internal Conflict probability			
21	Current National Power Conflict Intensity	Current Conflicts Intensity		
22	Current Subnational Conflict Intensity			
23	Human Development Index	Poverty & Development	Socio-Economic Vulnerability	Vulnerability
24	Multidimensional Poverty Index			
25	Gender Inequality Index	Inequality		
26	Gini Coefficient			
27	Public Aid per capita	Aid Dependency		
28	Net ODA Received (% of GNI)			
29	Total Persons of Concern (absolute)	Uprooted people	Vulnerable Groups	
30	Total Persons of Concern (relative)			
31	Children Underweight	Other Vulnerable Groups Children under-5		
32	Child Mortality			
33	Prevalence of HIV-AIDS above 15years	Other Vulnerable Groups Health Conditions		
34	Tuberculosis prevalence			
35	Malaria mortality rate			
36	Relative number of affected population by natural disasters in the last three years	Other Vulnerable Groups Recent Shocks		
37	Prevalence of undernourishment	Other Vulnerable Groups Food Security		
38	Average dietary supply adequacy			
39	Domestic Food Price Level Index			
40	Domestic Food Price Volatility Index			
41	Hyogo Framework for Action	DRR implementation	Institutional	Lack of Coping Capacity
42	Government effectiveness	Governance		
43	Corruption Perception Index			
44	Access to electricity (% of population)	Communication	Infrastructure	
45	Internet Users (per 100 people)			
46	Mobile cellular subscriptions (per 100 people)			
47	Adult literacy rate			
48	Road density (km of road per 100 sq. km of land area)			
49	Access to Improved water source (% of pop with access)	Physical Connectivity		
50	Access to Improved sanitation facilities (% of pop with access)			
51	Physicians density	Access to health system		
52	Health expenditure per capita			
53	Measles immunization coverage			

2.3 Summary of indicators for the Planetary Security Initiative

One way of presenting the complex relations between environmental security, human security, political security and governance is given by Ligtvoet et al. (2017). See Figure 2.8. To ease analysis within the PBL projects on water-related studies and projects within the Planetary Security Initiative we have summarised the relevant indicators from Sections 2.2.1 to 2.2.9 within this frame work.

The results are summarised in four tables:

- Table 2.5: 16 indicators concerning environmental security,
- Table 2.6: 16 indicators concerning human security,
- Table 2.7: 28 indicators concerning political security,
- Table 2.8: 17 indicators concerning adaptive capacity and governance.

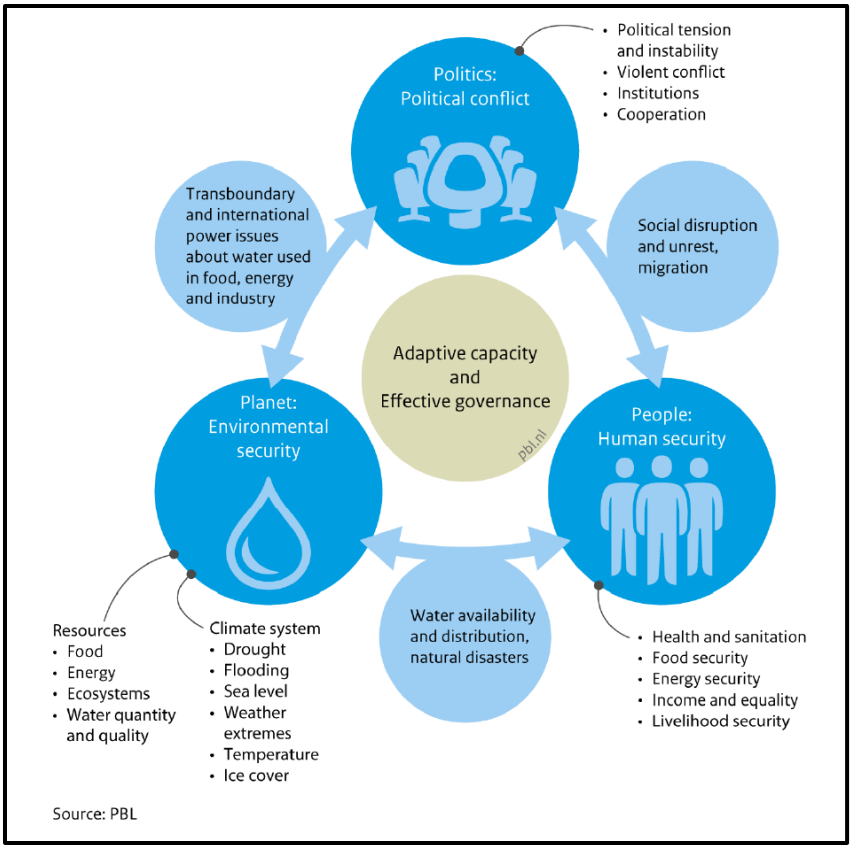


Figure 2.8 Conceptual representation of the interactions between the physical environment, human security and political conflict. Interactions are complex and context sensitive. Graph taken from Ligtvoet et al. (2017, p. 3).

Table 2.5 Indicators selected for *Environmental security,* as shown in the lower left corner of the scheme shown in Figure 2.8.

	Name of core indicator	**Category**	**Source**
1	Primary economic damage from floods, drought or tsunamis, as percentage of GDP (PPP)	Water-related disasters	database EMDAT from CRED Annual averages over the 1996–2015 period
2	Number of people affected by floods, drought or tsunamis, as percentage of population		
3	Number of people killed by floods, drought or tsunamis, as percentage of population		
4	Primary economic damage from geophysical, weather-related, biological and technological disasters, as percentage of GDP (PPP)	Disasters from all sources	
5	Number of people affected by geophysical, weather-related, biological and technological disasters, as percentage of population		
6	Number of people killed by geophysical, weather-related, biological and technological disasters, as percentage of population		
7	Energy import/export as percentage of total energy use (based on oil equivalent computations)	Resources	IEA, World Bank, 2014
8	Ores and metals exports, as percentage of merchandise exports		World Bank
9	Natural resources rents		
10	Forest area as percentage of total land area		
11	Agricultural land as percentage of total land area		
12	Available drinking water per capita (m^3)		FAO Aquastat
13	Endangered mammals	Ecosystems	UNEP World Conservation Monitoring Centre
14	Endangered plants		
15	Endangered birds		
16	Endangered fish specious		

Table 2.6 Indicators selected for *Human security,* as shown in the lower right corner of the scheme shown in Figure 2.8.

	Name of core indicator	**Category**	**Source**
1	Public aid per capita	Socio-economic	OECD DAC
2	Net ODA received		World Bank
3	Annual population growth as percentage (derived from exponential growth curve)		World Bank
4	Annual growth rate GDP as percentage		World Bank, OECD
5	Children underweight, under 5 years of age	Health	UNICEF
6	Child mortality, under 5 years of age		
7	Prevalence of HIV-AIDS, over 15 years of age		WHO
8	Tuberculosis prevalence		
9	Malaria mortality rate		
10	Prevalence of undernourishment	Food security	FAO
11	Domestic food price index		
12	Domestic food price volatility index		
13	Agricultural drought probability (average 1985–2014)		
14	Agriculture, value added (% of GDP)		World Bank
15	Access to improved water source (% of population with access)	Water-related security	WHO/UNICEF
16	Access to improved sanitation facilities (% of population with access)		

Table 2.7 Indicators selected for *Political security,* as shown in the upper corner of the scheme shown in Figure 2.8.

	Name of core indicator	Category	Source
1	Level of perceived criminality in society	Internal conflict drivers	EIU Country Analysis team
2	Number of internal security officers and police per 100,000 people		UNODC survey
3	Number of homicides per 100,000 people		UNODC survey
4	Number of people jailed within the national population, per 100,000		International Centre for Prison studies
5	Ease of access to small arms and light weapons		EIU Country Analysis team
6	Intensity of organised internal conflict		EIU Country Analysis team
7	Likelihood of violent demonstrations		EIU Country Analysis team
8	Level of violent crime		EIU Country Analysis team
9	Political instability		EIU Country Analysis team
10	Political terror scale		Gibney et al. (2011)
11	Weapons imports per 100,000 people		SIPRI arms database
12	Impact of terrorism		IEP
13	Number of deaths from organised conflict (internal)		IISS armed conflict database
14	Internal conflicts fought		IEP and UCDP
15	Military expenditure (% GDP)	External conflict drivers	ISS Military Balance 2016
16	Number of armed services personnel per 100,000 people		ISS Military Balance 2016
17	UN peacekeeping funding		IEP and UN
18	Nuclear and heavy weapons capabilities		IEP, SIPRI, UN
19	Weapons exports per 100,000 people		SIPRI arms database
20	Refugees and Internal Displaced People (IDPs)		UNHCR
21	Relationships with neighbouring countries		EIU Country Analysis team
22	Number, duration and role in external conflicts		UCDP
23	Number of deaths from organised external conflicts		IISS, EIU and the Iraq Coalition Casualty Count
24	Number of people under 14 as percentage of the total population	Demographic	UN-DP and World Bank
25	Population size		UN-DP and World Bank
26	Unemployment	Socio-economic	UN-DP
27	GDP per capita PPP		World Economic Outlook
28	Education		UN-DP

Table 2.8 Indicators selected for *Adaptive capacity and Effective governance,* as shown in the middle of the scheme shown in Figure 2.8.

	Name of core indicator	**Category**	**Source**
1	Corruption perception index	Governance	Transparency International
2	Government effectiveness		World Bank
3	Hyogo framework for action (DRR implementation)		ISDR
4	Access to electricity (% of population)	Communication and infrastructure	World Bank
5	Internet users (per 100 people)		World Bank
6	Mobile cellular subscriptions (per 100 people)		World Bank
7	Road density (km of road per 100 sq. km land)		Open Street Maps
8	Education Index	Human development	UN-DP
9	Adult literacy rate		UNESCO
10	Number of people living on less than 3 US dollars a day, as percentage of total population		
11	Urban population as percentage of total		World Bank
12	Human happiness		SDSN
12	Health expenditure per capita	Access to health system	WHO
13	Physicians density		
14	Measles immunisation coverage		
15	Ease of doing business index	Economic development	World Bank
16	Gini Coefficient		World Bank
17	Gender Inequality Index		UN-DP

2.4 Software implementation

All data described in Sections 2.2 and 2.3, but one, are public domain and have been downloaded from the institutes' websites. Exception is the NatCat natural disaster database of Munich Re. However, we were able to download Munich Re country statistics from a GermanWatch publication (Section 3.2.4).

To couple these databases/indicators into one new database, we have chosen a common set of country names, those chosen by JRC for their INFORM and GCRI databases (191 countries). Next to that we have chosen a common year for which the data have been derived, in this case **the year 2016**. We were able to download 2016 data for most indicators. However, there are exceptions such country data for clean water and improved sanitation. These data are for the year 2015. In a few cases, such as the number of homicides, we had to take data from the 2011–2015 period, because data on specific countries over specific years were lacking.

The coupling of data has been performed in S-Plus (version 8.2). The script is given in Appendix B. We note that the script language of S-Plus equals the script language of R. We denote the database by the acronym 'PSI', where PSI stands for 'Planetary Security Initiative'.

We note that the PSI database is not unique in the sense that a wide range of indicators are combined into one dataset. Two other databases are published by The Economist (2018) and by Rosling et al. (2018). However, the set-up chosen in these publications differs the one chosen here, i.e. Figure 2.8 and Tables 2.5 through 2.8.

3 Human security composite indicators

3.1 From indicators to composite indicators

Thus far we showed national-based indicators in the field of human security. However, many researchers combine two or more indicators into a new *composite indicator*. An example has been given in Table 2.3. Here, 23 indicators—covering the field of violence and conflict—were combined into one new composite, denoted as Global Peace Index. Each indicator has been awarded a weight chosen by a team of experts. Before averaging, indicators were scaled (normalised) between 1.0 and 5.0 to make them comparable.

It is important to note that this procedure of combining indicators involves a number of steps and decisions that shape the new composite indicator. Different decisions on weighing, normalisation or imputation (interpolation of missing data) may lead to composites that show deviating patterns, when compared. Patterns may deviate even more, if institutes take differing decisions on expressing indicators either in absolute or relative terms, as we show in Section 5.5.

It is important to realise these aspects, since indicators presented by different researchers or institutes may or may not show deviating global patterns. Chapter 5 compares composite indicators with similar descriptions (‘governance’, ‘impact of natural disasters’, ‘vulnerability’, ‘risk of conflict’) and highlights the role of various procedures.

Typical examples of the various procedures are: (i) logarithms taken from the original data, to diminish the effect of outliers, and (ii) the way indicators are aggregated: arithmetic mean versus geometric mean. And, if the mean is calculated over M indicators — where a small number of indicators have data missing — is the result missing or calculated over the data available?

For an overview of techniques, we refer to Saisana et al. (2005), JRC-OECD (2008) and the COIN website of JRC. Description of procedures applied by JRC, such as for their INFORM database, is given by JRC (2017b, Chapters 4 and 6).

3.2 Human security composites

3.2.1 Joint Research Centre: global risks

The Joint Research Centre (JRC) composed a number of composite indicators for human security. For the INFORM database, these are summarised in the left-hand column of Table 2.4B and Table 3.1A. At the highest level, all 53 indicators are taken together in a global risk composite. Figure 3.1 gives an example of the composites. GCRI composites are shown in Table 3.1B.

Table 3.1A Overview of INFORM composite indicators

Ranking level	INFORM																			
Concept level (Dimensions)	Hazard & Exposure								Vulnerability							Lack of Coping Capacity				
Functional level (Categories)	Natural						Human		Socio-Economic			Vulnerable Groups				Institutional		Infrastructure		
Component level	Earthquake	Tsunami	Flood	Tropical cyclone	Drought	Current Conflict Intensity	Projected Conflict Risk		Development & Deprivation (50%)	Inequality (25%)	Aid Dependency (25%)	Uprooted People	Other Vulnerable Groups			DRR	Governance	Communication	Physical Infrastructure	Access to Health System

Table 3.1B Overview of GCRI composite indicators.

POLITICAL					SECURITY			SOCIAL						ECONOMY					GEOGRAPHY AND ENVIRONMENT				
Regime Type	Lack of Democracy	Government Effectiveness	Level of Repression	Empowerment Rights	Recent Internal Conflict	Neighbours with HVC	Years since HVC	Corruption	Ethnic Power Change	Ethnic Compilation	Transnational Ethnic Bonds	Homicide Rate	Infant Mortality	GDP per capita	Income Inequality	Openness	Food security	Unemployment	Water Stress	Oil Production	Structural Constraints	Population Size	Youth Bulge (male and female)

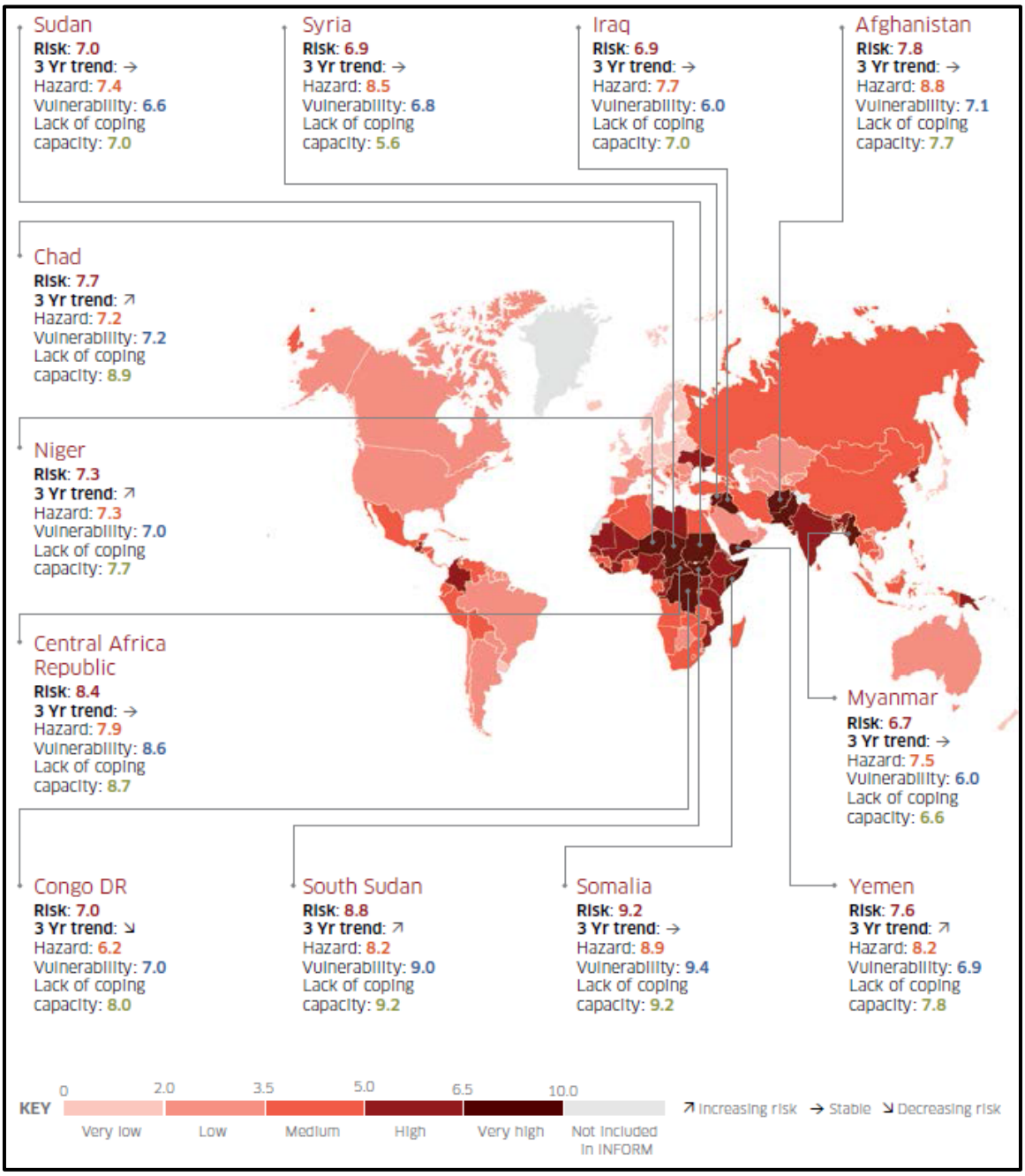


Figure 3.1 Risk of humanitarian crises and disasters INFORM 2017 index.

3.2.2 Central Emergency Response Fund: global emergencies

The Central Emergency Response Fund (CERF) was introduced in 2006 as the UN's global emergency fund as part of the UN Office for the Coordination of Humanitarian Affairs (OCHA). The fund delivers to humanitarian requests and provides disaster aid during crises. OCHA is funded by donor countries on voluntary bases.

The Netherlands is a major funder, with 750 million USD donated over the 2006–2018 period. Only Sweden (849 million USD) and the United Kingdom (1099 million USD) have donated more, over the same period. Funds are allocated on the basis of a number of criteria, in the form of rapid responses, underfunded emergencies and loans.

The CERF Index for Risk and Vulnerability is used to analyse the level of risk, vulnerability and humanitarian needs in a country. The Index for Risk Management (INFORM) accounts for 50% of CERF because this risk index already includes a major part of the aspects analysed when OCHA grants funds (Table 3.2)

Table 3.2 The CERF index for Risk and vulnerability is composed from a large number of sub-indicators. See: http://www.unocha.org/cerf .

CERF Index for Risk and Vulnerability (CIRV)	
50% of CIRV	**50% of CIRV**
Index for Risk Management (INFORM) Accounts for 1/2 of CIRV Includes about 50 indicators Based on quantitative data Forward-looking (3-5 years) Dimensions include conflict, natural disaster, displaced and other vulnerable people, coping capacity	**Projected risk of increase in humanitarian needs** From IASC Alert, Early Warning & Readiness Report Accounts for 1/12 of CIRV Based on qualitative assessments Forward-looking (6 months)
	Food Insecurity From FEWSNet Food Assistance Outlook Brief, FAO's Global Information and Early Warning System, and WFP's Vulnerability Analysis and Mapping Accounts for 1/12 of CIRV Based on quantitative data on food insecurity Forward-looking (6 months)
	Prevalence of conflict From Uppsala Conflict Data Program Accounts for 1/12 of CIRV Based on quantitative data on civil and int'l conflict
	Change in conflict intensity and conflict risk alert From International Crisis Group Accounts for 1/12 of CIRV Based on qualitative assessment of conflict Conflict risk alerts are forward-looking
	Human rights violations From Political Terror Scale Accounts for 1/12 of CIRV Based on US State Department, Amnesty International, Human Rights Watch reports

3.2.3 The Fund for Peace: fragile states

The Fund for Peace is a non-profit and educational organisation based in the United States, working on projects studying violent conflict and promoting sustainable security. The organisation is funded by private citizens, governments, corporations and foundations. Since 2005 the Fund for Peace publishes the Fragile State Index[2]. This index is based on a number of social, economic and political indicators. Every indicator is constructed out of a number of underlying variables that are available on the Fragile State Index website. See Table 3.3.

Table 3.3 The Fragile State Index is a composite indicator based on 12 underlying sub-indicators.

Social Indicators

Demographic Pressures

Pressures on the population such as disease and natural disasters make it difficult for the government to protect its citizens or demonstrate a lack of capacity or will.

Includes pressures and measures related to:

- Natural Disasters
- Disease
- Environment
- Pollution
- Food Scarcity
- Malnutrition
- Water Scarcity
- Population Growth
- Youth Bulge
- Mortality

Refugees and IDPs

Pressures associated with population displacement. This strains public services and has the potential to pose a security threat.

Includes pressures and measures related to:

- Displacement
- Refugee Camps
- IDP Camps
- Disease related to Displacement
- Refugees per capita
- IDPs per capita
- Capacity to absorb

Group Grievance

When tension and violence exists between groups, the state's ability to provide security is undermined and fear and further violence may ensue.

Includes pressures and measures related to:

- Discrimination
- Powerlessness
- Ethnic Violence
- Communal Violence
- Sectarian Violence
- Religious Violence

Human Flight & Brain Drain

When there is little opportunity, people migrate, leaving a vacuum of human capital. Those with resources also often leave before, or just as, conflict erupts.

Includes pressures and measures related to:

- Migration per capita
- Human Capital
- Emigration of Educated Citizens

Economic Indicators

Uneven Economic Development

When there are ethnic, religious, or regional disparities, governments tend to be uneven in their commitment to the social contract.

Includes pressures and measures related to:

- GINI Coefficient
- Income Share of Highest 10%
- Income Share of Lowest 10%
- Rural v. Urban Distribution of Services
- Improved Service Access
- Slum Population

Poverty & Economic Decline

Poverty and economic decline strain the ability of the state to provide for its citizens if they cannot provide for themselves and can create friction between "haves" and "have nots".

Includes pressures and measures related to:

- Economic Deficit
- Government Debt
- Unemployment
- Youth Employment
- Purchasing Power
- GDP per capita
- GDP Growth
- Inflation

Political and Military Indicators

State Legitimacy

Corruption and lack of representativeness in the government directly undermine social contract.

Includes pressures and measures related to:

- Corruption
- Government Effectiveness
- Political Participation
- Electoral Process
- Level of Democracy
- Illicit Economy
- Drug Trade
- Protests and Demonstrations
- Power Struggles

Public Services

The provision of health, education, and sanitation services, among others, are key roles of the state.

Includes pressures and measures related to:

- Policing
- Criminality
- Education Provision
- Literacy
- Water & Sanitation
- Infrastructure
- Quality Healthcare
- Telephony
- Internet Access
- Energy Reliability
- Roads

Human Rights & Rule of Law

When human rights are violated or unevenly protected, the state is failing in its ultimate responsibility.

Includes pressures and measures related to:

- Press Freedom
- Civil Liberties
- Political Freedoms
- Human Trafficking
- Political Prisoners
- Incarceration
- Religious Persecution
- Torture
- Executions

Security Apparatus

The security apparatus should have a monopoly on use of legitimate force. The social contract is weakened where affected by competing groups.

Includes pressures and measures related to:

- Internal Conflict
- Small Arms Proliferation
- Riots and Protests
- Fatalities from Conflict
- Military Coups
- Rebel Activity
- Militancy
- Bombings
- Political Prisoners

Factionalized Elites

When local and national leaders engage in deadlock and brinksmanship for political gain, this undermines the social contract.

Includes pressures and measures related to:

- Power Struggles
- Defectors
- Flawed Elections
- Political Competition

External Intervention

When the state fails to meet its international or domestic obligations, external actors may intervene to provide services or to manipulate internal affairs.

Includes pressures and measures related to:

- Foreign Assistance
- Presence of Peacekeepers
- Presence of UN Missions
- Foreign Military Intervention
- Sanctions
- Credit Rating

[2] From 2005 until 2014 the index was called the Failed State Index, but as a result of repeated criticism the name was changed into the Fragile State Index.

The data underlying the sub-variables is not publicly available, although both large scale data sets from the UN, World Bank and the WHO are being used together with regional and local data sets. Data used for the index is both quantitative and qualitative interpreted and valued by expert validation. The composite indicator 'fragility' indicates the political stability of a state.

The index is being used by the Organisation for Economic Cooperation and Development (OECD), in their states of fragility reports (OECD, 2018). However, the index has also been criticised by academics and journalist for a lack of utility and its negative voice in the development debate (Leigh, 2013). A global map is shown in Figure 3.2.

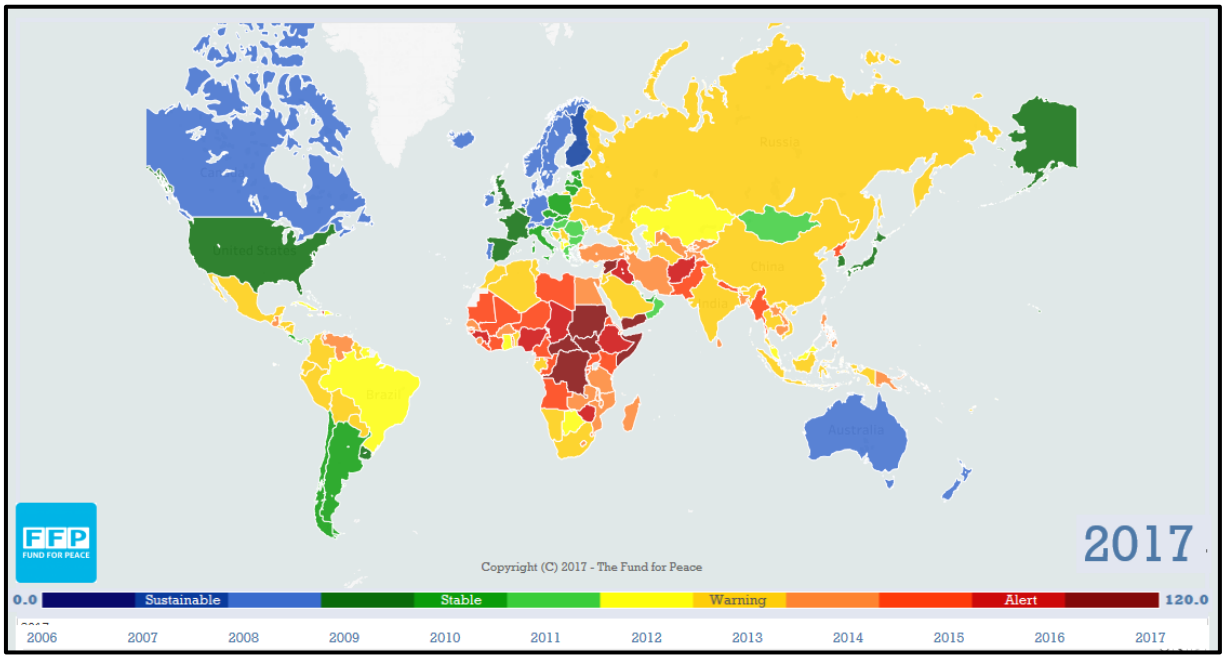


Figure 3.2 Fragile state index 2017 (The Fund for Peace, 2017). See their website.

3.2.4 Germanwatch, BEH Stuttgart and UNISDR: disaster risks

Germanwatch – Climate Risk Index

Germanwatch is an organisation that advocates since 1991 for global equity and preservation of livelihoods, especially for people in the global South. Every year the organisation publishes the Global Climate Risk Index (CRI). This index gives an analysis of the extent to which countries have been affected by the impacts of weather-related events (e.g. storms, floods).

The indicator is based upon the absolute death toll, the death toll per 100,000 inhabitants, the absolute losses in USD, and the relative losses in terms of GDP and the human development score per country. How these values are combined, is not clear from the reports. In general, less-developed countries are more vulnerable to climate change impacts than more-developed countries. A global map is shown in Figure 3.3A.

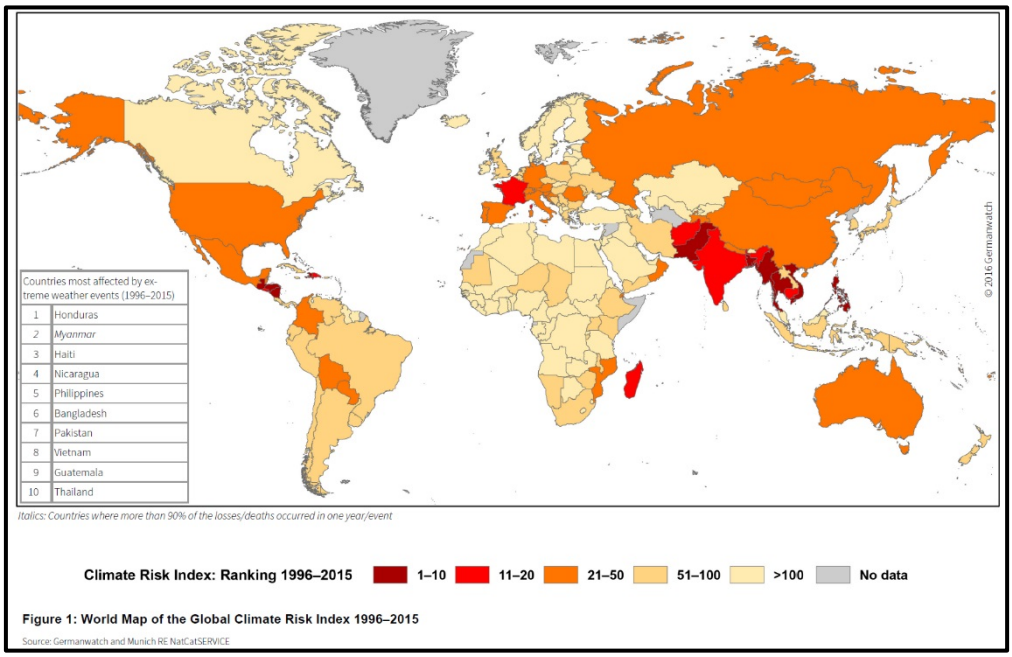


Figure 3.3A Germanwatch CRI Ranking 1996–2015. A lower score indicates a higher impact. https://germanwatch.org/en/download/10333.pdf (Germanwatch, 2015).

BEH Stuttgart and UNU – World Risk Index

The Institute of Regional Development Planning, part of the university of Stuttgart, with among other partners the United Nations University, Institute for Environment and Human Security (UNU-EHS), publishes an annual World Risk Index. This index is the product of cooperation between scientists and practice people. The index is meant for practitioners in the fields of disaster risk reduction, spatial planning, and insurance and reinsurance.

The index analyses the risk, vulnerability and exposure to natural risks, on country scale, see Figure 3.3B. The World Risk Index gives another picture than the CRI as illustrated in Figure 3.3C.

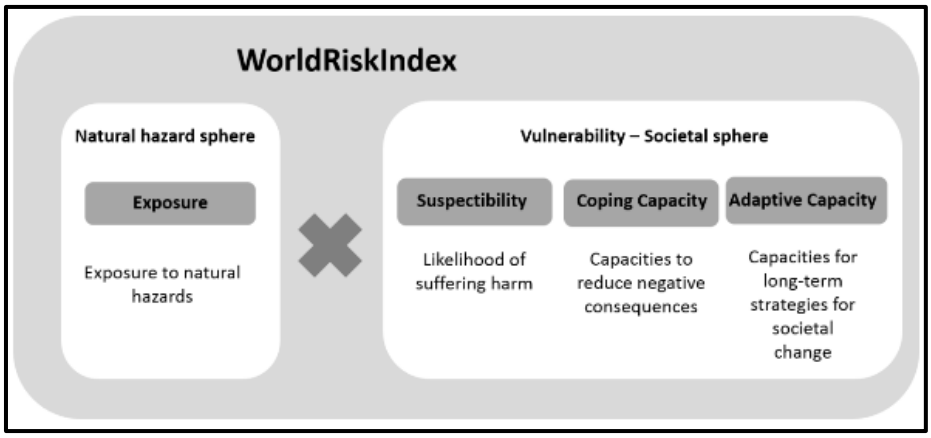


Figure 3.3B Conceptual set-up of the World Risk Index (BEH Stuttgart, 2018).

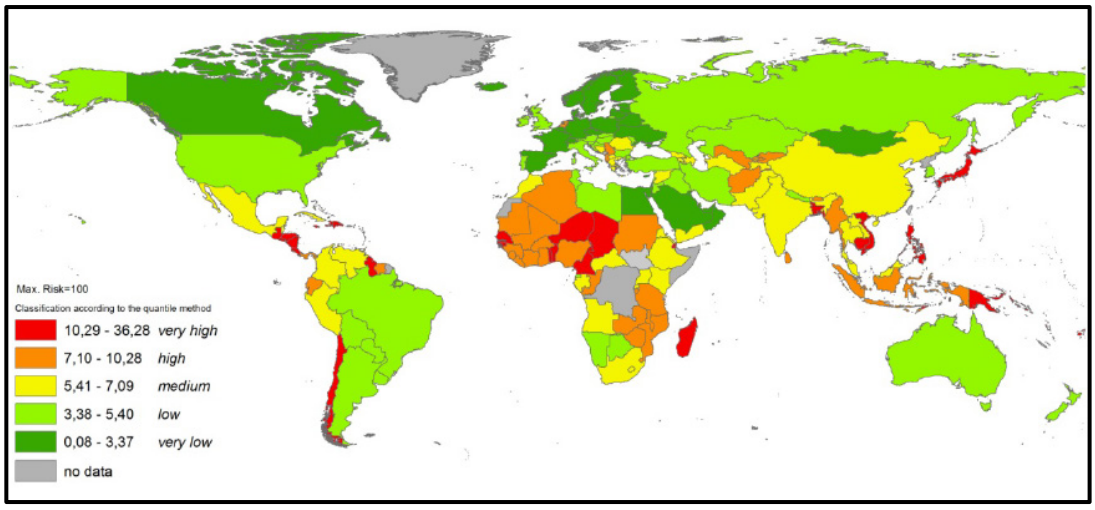


Figure 3.3C World Risk Index 2016 as the result of exposure and vulnerability. Red means more impacted, green less impacted (Birkmann and Welle, 2016).

UNISDR – GAR

The United Nations on Disaster Risk Reduction (UNISDR) was established in 1999 as a secretariat to facilitate, coordinate and ensure synergies of UN work on disaster risk reduction. The biennial Global Assessment Reports (GAR) by the UNISDR are developed on the basis of a large body of work by a wide range of independent scientific institutions, think thanks, UN organisations, governments, NGOs, and businesses. The GAR is a global assessment of disaster risk reduction and comprehensive review and analysis of the natural hazards that are affecting humanity. Nationally reported losses are presented in terms of mortality and combined economic losses—a combination of among other factors absolute losses and social expenses.

The GAR aims to focus on international attention for the issue of disaster risk reduction and encourage political and economic support for DRR. Additionally, the GAR meant as a tool to assess the implementation of the Sendai Framework for Disaster Risk Reduction though to 2030. A global map is shown in Figure 3.3D.

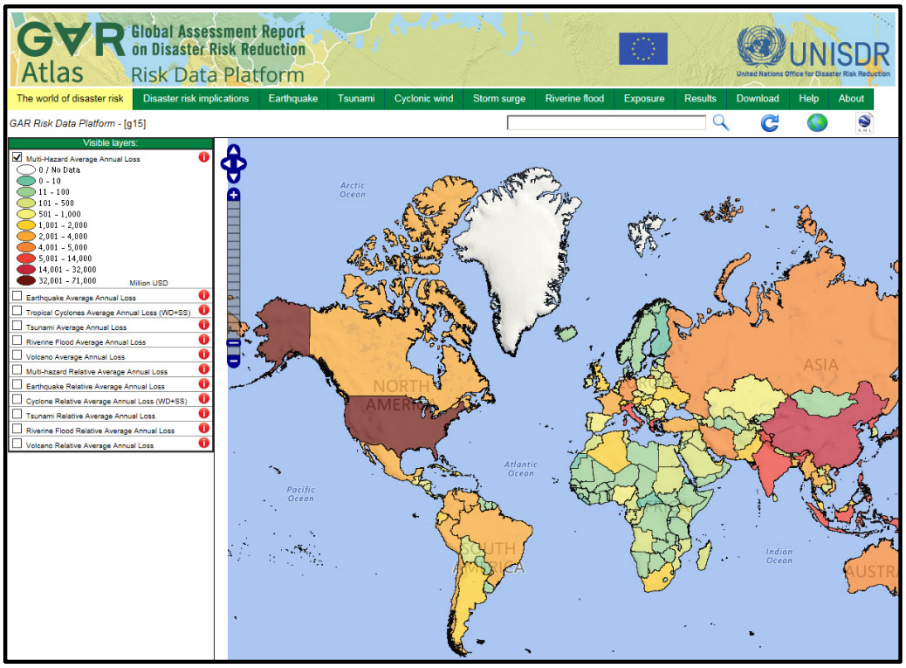


Figure 3.3D Risk map from the GAR atlas. See UNISDR and Noy (2014).

3.2.5 Institute for Economics & Peace: Global Peace Index

The Institute for Economics and Peace (IEP) launches the Global Peace Index (GPI) annually since 2007 (see Section 2.2.6). Details on the Global Peace Index 2017 can be found here. For details see Section 2.2.6.

3.3 Summary of composite indicators for the Planetary Security Initiative

We have summarised all composite indicators described in Section 3.2 in Table 3.4, yielding an overview of 23 indicators, categorised into six groups. A comparison within these categories is given in Section 5.5.

Table 3.4 Summary of composite indicators described in this chapter.

	Name of composite indicator	Source	Category
1A	Vulnerability component of INFORM database	Joint Research Centre	Vulnerability
1B	Vulnerability component of Global Adaptation Index Note: uses both historic and projected indices	University of Notre Dame	
1C	Vulnerability component of World Risk Index	BEH Stuttgart	
1D	Coping capacity component of INFORM database	Joint Research Centre	Coping capacity
1E	Coping capacity component of World Risk Index	BEH Stuttgart	
1F	Readiness for adaptation index. Combines economic, social and governance aspects. Note: uses both historic and projected indices	University of Notre Dame	Adaptation
2A	Governance in six dimensions: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption.	World Bank, Kaufman (2015)	Governance, corruption, institutions
2B	Corruption perception index	Transparency International	
2C	Governance	INFORM project of Joint Research Centre	
3A	World Risk Index. Combines exposure and vulnerability for five natural hazards.	BEH Stuttgart	Natural disasters
3B	Natural hazards component of INFORM database. Combines impacts from four natural hazards.	Joint Research Centre	
3C	Global Climate Risk Index (CRI). Combines fatalities and economic losses from extreme weather events.	German Watch and Munich Re	
3D	Direct impacts of natural disasters using the idea of lost life years (applied in the Global Assessment report 2015)	Univ. of Wellington and UNISDR	
3E	Transnational impacts of climate change (the TCI index)	Stockholm Environmental Institute (SEI)	Transnational climate impacts
4A	Multi-dimensional Poverty Index (MPI)	UN Development Programme	Socio-economic
4B	Human Development Index (HDI)	UN Development Programme	

5A	Global Peace Index. Combines internal and external conflict drivers	Institute for Economics & Peace	Conflicts
5B	Conflict probability, based on the Global Conflict Risk Index (GCRI)	Joint Research Centre	
5C	Human-induced risks (conflicts), taken from the INFORM database	Joint Research Centre	
6A	CIRV: CERF Index for Risk and Vulnerability (consists for 50% of INFORM risk)	UN-OCHA	All risks combined
6B	INFORM global risk index. Combines hazards, conflict, vulnerability and lack of coping capacity.	Joint Research Centre	
6C	Fragile States Index. Combines social, economic, political and military indicators.	The Fund for Peace (FFP)	

3.4 Software implementation

All composite indicators shown in Table 3.4, are implemented in the PSI database as described in Section 2.4 and Appendix B.

4 Temporal and spatial coherence

4.1 Nature of temporal patterns

Most of the indicators described in Chapters 2 and 3 contain spatio-temporal information, that is information both on country scales and the evolution over time. Figure 4.1 shows an example for the *corruption perception indicator* of the World Bank (cf. Figure 2.4 and Kaufman and Kraay, 2015). The graph shows a scatterplot with 2016 values on the y-axis and 2000 values on the x-axis. Also 68% uncertainty bands are given. This indicator varies from -2.5 (weak governance) to +2.5 (strong governance).

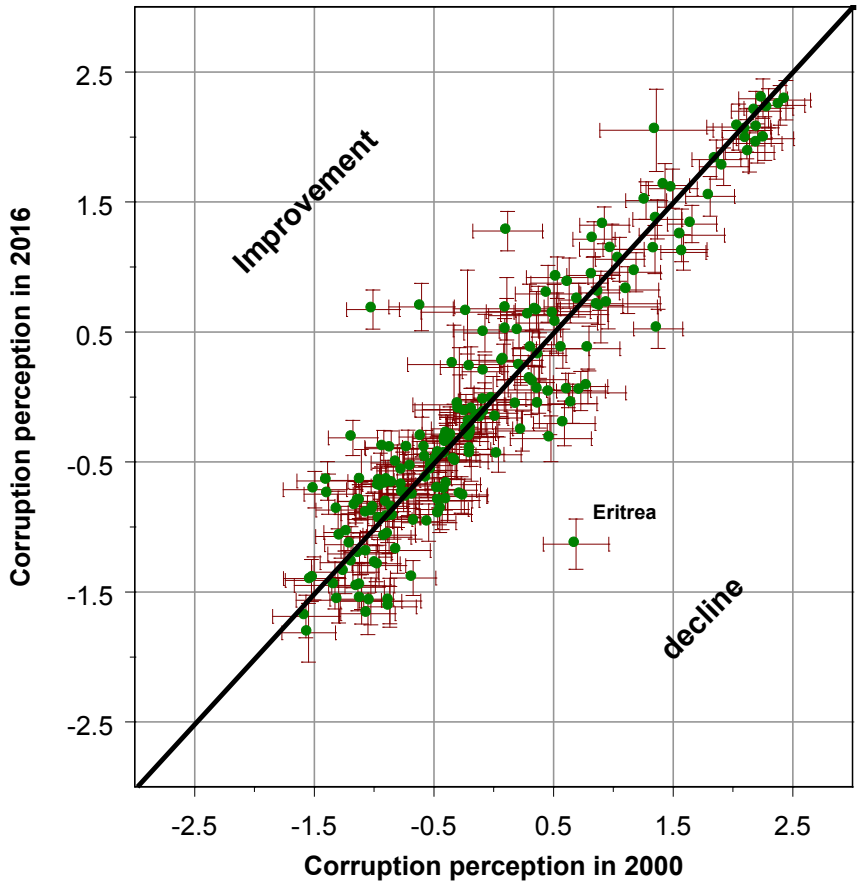


Figure 4.1A Scatterplot showing the coherence between corruption perception data in 2000 (x-axis) and 2016 (y-axis). Data taken from the World Bank (cf. Figure 2.4). The outlier with a value of +0.7 in the year 2000 and -1.1 in the year 2016 is Eritrea.

The graph shows a strong linear, 1-to-1 relationship, apart from a few outliers. The outlier at the right of the 1-to-1 line is Eritrea, showing a sharp decrease in governance over the 2000–2016 period (a historical overview of human rights in Eritrea can be found here).

A second example is given in Figure 4.1B. The graph shows the time evolution of countries (1990–2015) as in the Education index, provided by the UN Development Reports (cf. Figure 2.5B). The graph shows that education levels gradually improve, over time, with only a few exceptions.

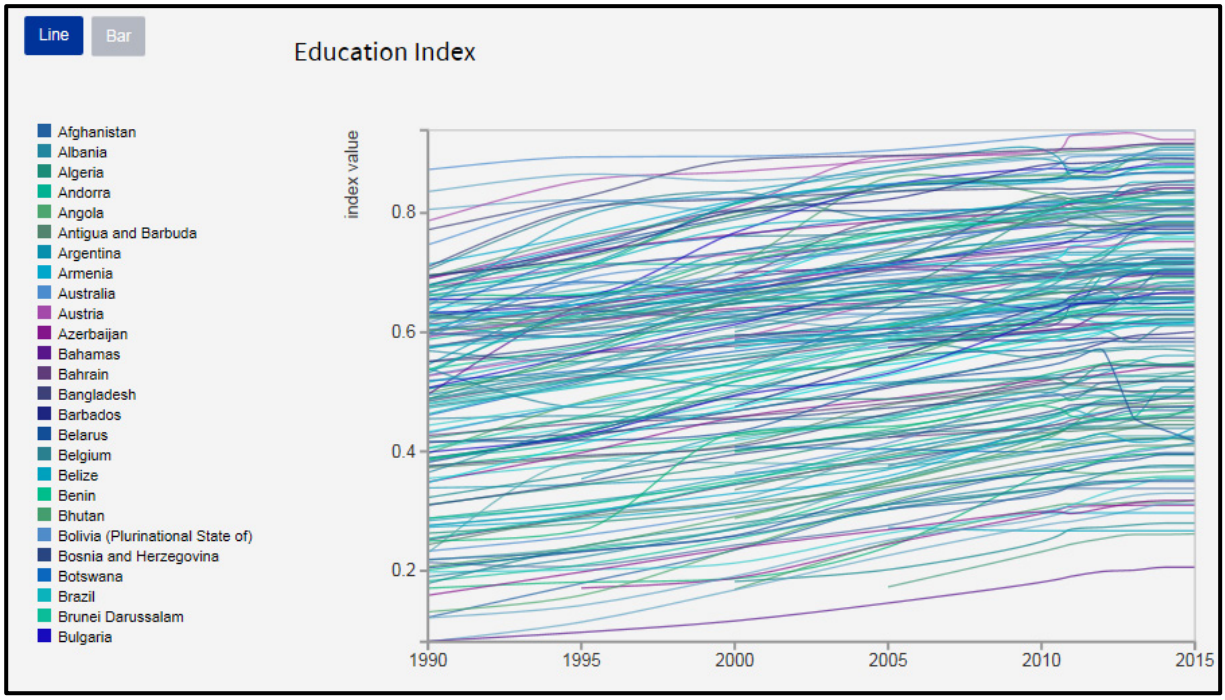


Figure 4.1B Temporal patterns of education levels for 188 countries over the 1990–2015 period. Source: UN-DP Human development reports.

A third example is taken form the GapMinder tool as published by Rosling et al. (2018). This tool contains a wide range of global indicators with advanced visualisation tools. We show two screenshots in Figure 4.1C. The graph shows the relationship between GDP per capita on the x-axis and child mortality on the y-axis. The colour of symbols refers to one of four regions in the world, while the size of symbols relates to the size of the national population. The tool has an animation mode showing the time evoluation of the indicators involved. The tool illustrates that many indicators evolved gradually in the direction of better/more positive values. Exceptions are those countries where conflict erupted or intensified.

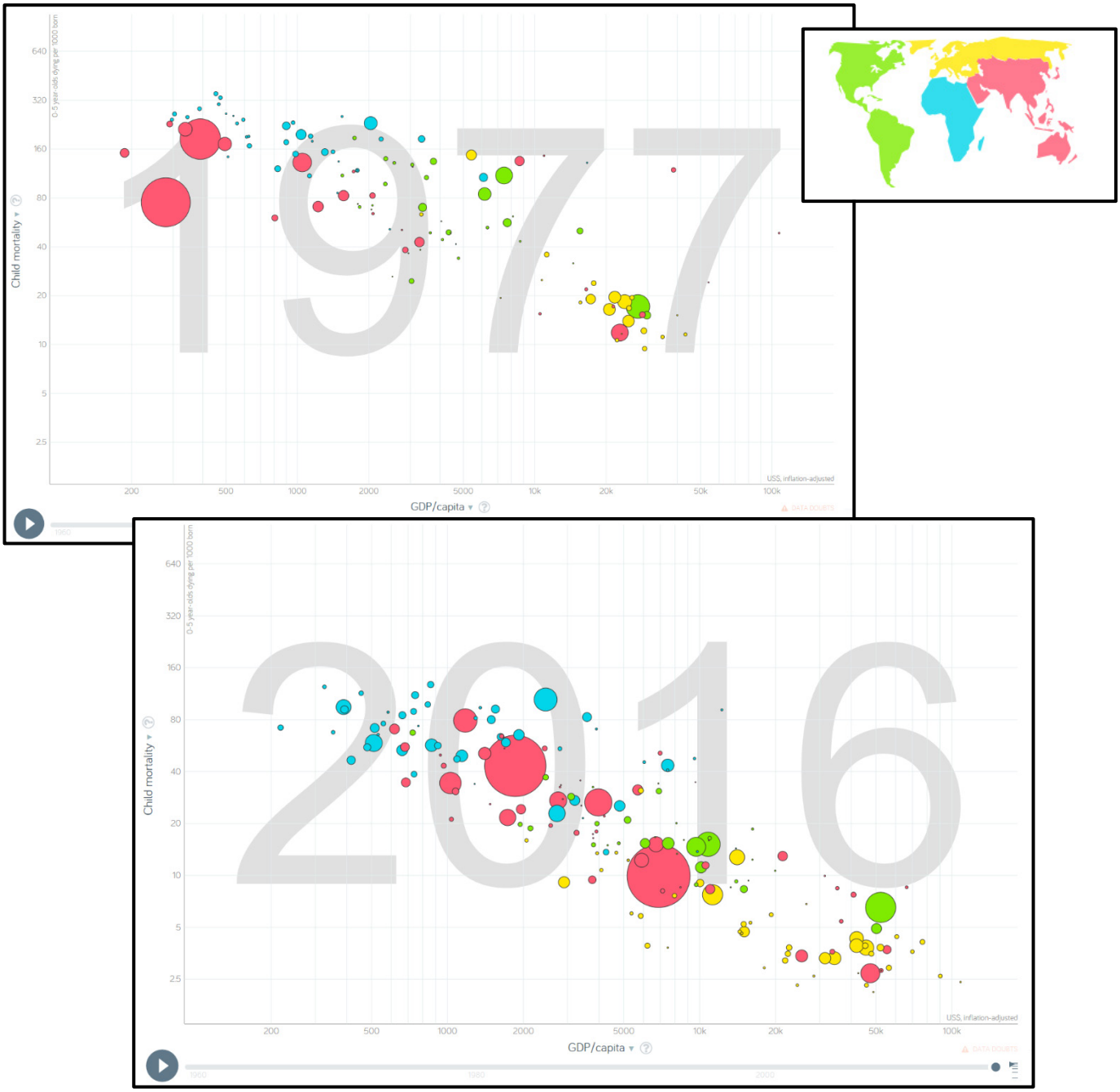


Figure 4.1C The relationship between GDP per capita on the x-axis and child mortality on the y-axis. The upper panel is for the year 1977, the lower panel for the year 2016. Each symbol (circle) stands for a country where the size of the circle is relative to the population size. Colours correspond to one of the four continents given in the inset. Larges changes are seen for China and India (largest red symbols). Graphs are drawn with the GapMinder tool, given by Rosling et al. (2018).

Not all indicators show a smooth temporal evolution as shown in Figure 4.1B. An important exception are impacts of natural disasters. Disasters such as earth quakes, droughts or floods can hit a country in one year after an absence of, say, 20 years. To illustrate this, we calculated the global temporal evolution (1990–2015) for four impact indicators. See figures 4.2A and 4.2 B.

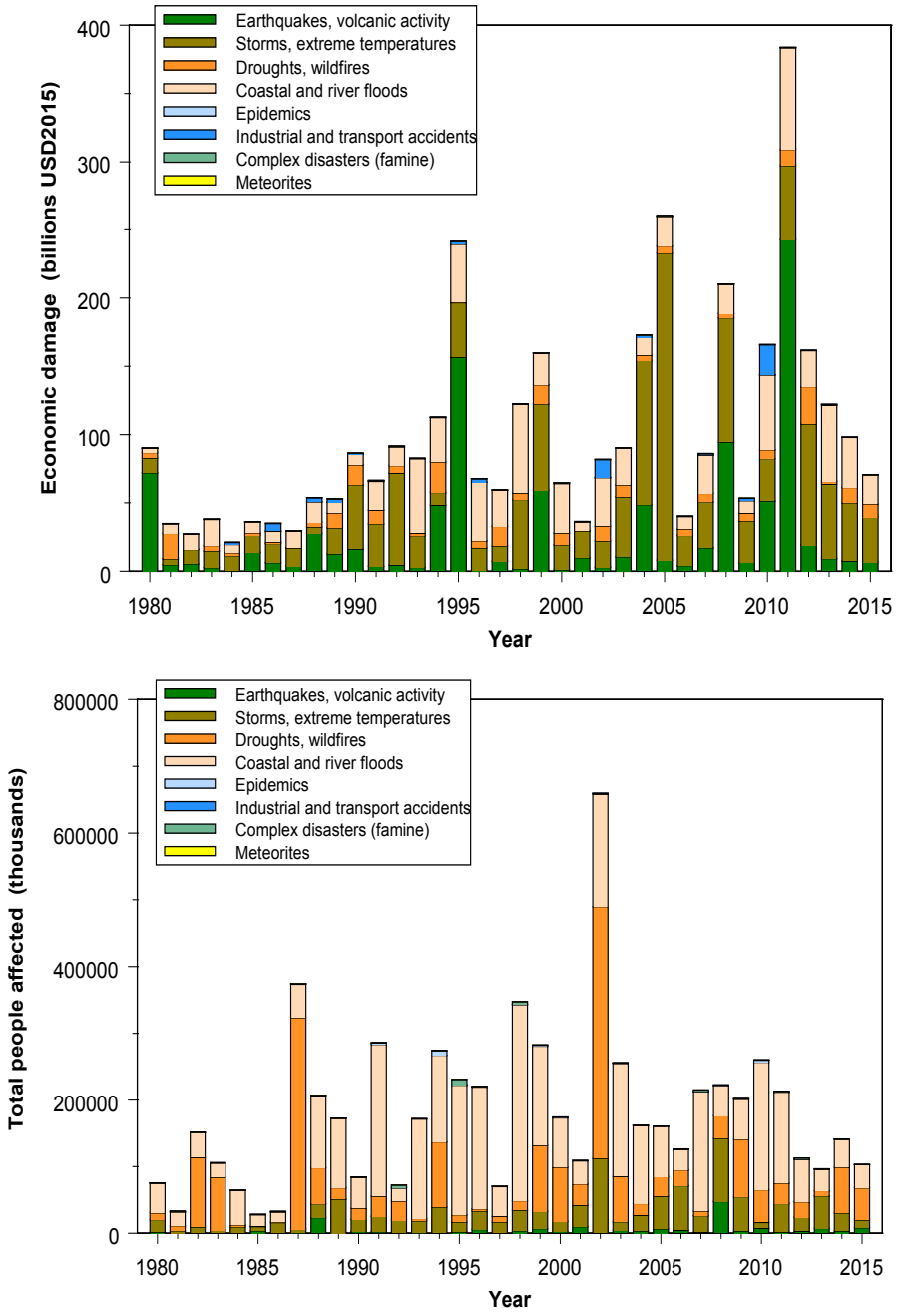


Figure 4.2A Global economic damage (upper panel) and the total number of people affected for eight categories of disasters. Data are taken from the EM-DAT database of CRED (cf. Section 2.2.1).

Therefore, it is better to take impact averages over time, rather than impacts per country for the year 2016 or alike, if one aims to perform statistical analyses as we do in Part II of this study.

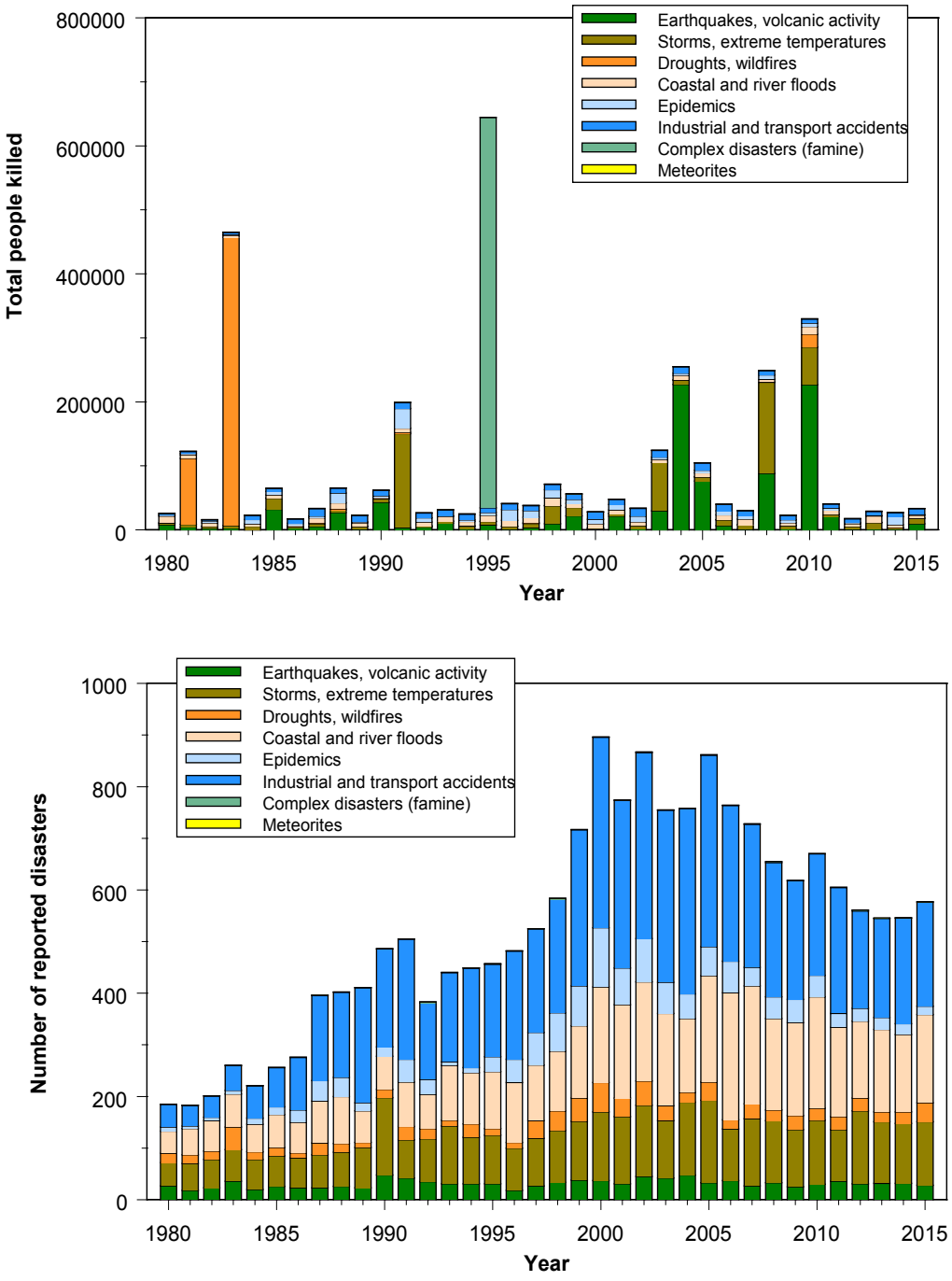


Figure 4.2B Global number of people killed (upper panel) and the number of reported disasters (lower panel) for eight categories of disasters. Data are taken from the EM-DAT database of CRED (cf. Section 2.2.1).

4.2 Nature of spatial patterns

It has been suggested in many studies that global security indicators show spatial correlated patterns. We refer to the work of Buhaug (2005) and Goldstone et al. (2010) for conflict-related indicators, and to Sachs et al. (2001) for economic development indicators.

To study the spatial coherence of indicators, we constructed for 191 countries a binary 191 by 191 neighbouring matrix N that contains a '0' in field (i,j) if country i is not a neighbour of country j, else a '1'. Clearly, if country i is an island, row i of matrix N contains only zeros.

Now, if we have an arbitrary indicator I with values of each of the 191 countries, with I = (I_1, I_2, ... , I_{191}), we can calculate any statistic of interest from the vector

$$(N_{i,1} * I_1 , N_{i,2} * I_2 , ... , N_{i,191} * I_{191})$$

such as the mean, maximum or minimum value for each country i, with i = 1, ... , 191.

An example for indicator I taken as 'GDP PPP per capita' is shown in figure 4.3. Here we calculated the mean of GDP per capita for all surrounding countries of country i. The black line is the 1-to-1 line if GDP per capita would show a 100% correlation between one country and its neighbors. The graphs show a reasonable relationship between a country and its neighbors, but there are also exceptions, such as Yemen and Qatar. Further applications are given in the Part-II-report.

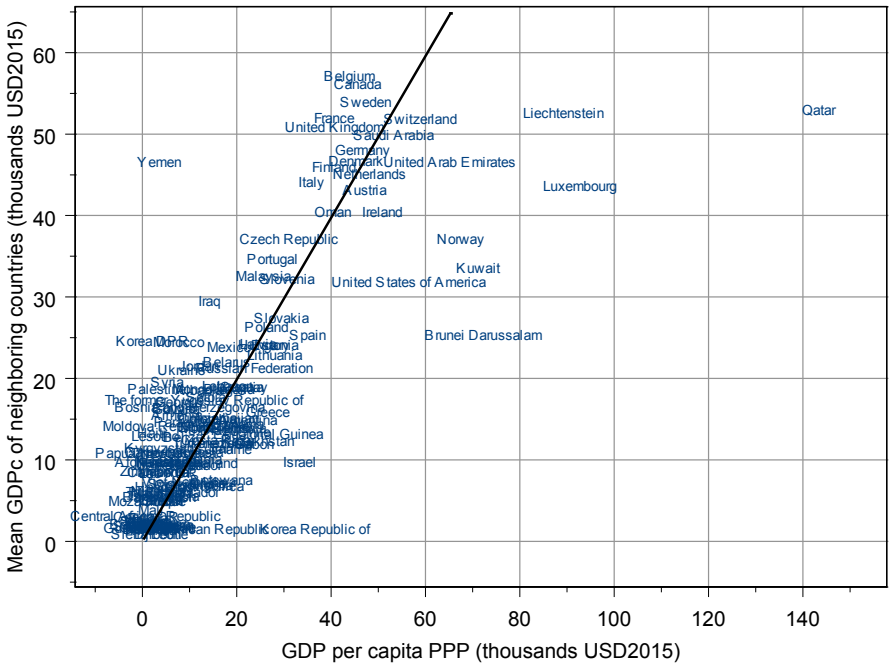


Figure 4.3 Relationship between the GDP per capita between one country and the mean of its neigboring countries. Data are for the year 2015.

5 Sources of uncertainty, quality assurance

World Bank data show that the percentage of households with improved sanitation in Syria accounts for 97% and equivalently in China 76% (for the year 2015). Yet the question is: how reliable are these numbers? There are many reasons why such numbers are uncertain, varying from rough estimates since statistics are hardly available for countries in conflict, to numbers that are flattered due to propaganda, to various interpretations of the term 'improved sanitation', or to data that were interpolated since they were missing and were filled in by expert judgment.

In this chapter, we identify a number of sources of uncertainty and—where possible—give directions about how to quantify these uncertainties. Knowledge on uncertainties may help to test the robustness of findings, such as those presented in Part II of this study. The need for uncertainty information is illustrated in the book by Morten Jerven (2013) for African countries: 'Poor numbers. How we are misled by African development statistics and what to do about it'.

In the following sections, we briefly describe a number of uncertainty sources, although this list is not exhaustive. We refer to Sluijs (2003) and Petersen et al. (2012). For details on building composite indicators and their sensitivity analyses, we refer to JRC-OECD (2008).

5.1 Data quality and statistical capacity

Information on uncertainties in the literature or databases described in Chapters 2 and 3 appears to be very limited. Positive exceptions are the governance indicators as published by the World Bank (Section 2.2.4 and Figure 2.4), and data on conflict and violence-related deaths as published by the Uppsala Conflict Data Program (Section 2.2.7). These institutions give uncertainty bands around their indicator values, divided into individual countries. An example of these bands is given in Figure 4.1A.

However, all other indicators or composite indicators as summarised in Tables 2.5 through 2.8 and Table 3.4 do not give such information. In this context, it is interesting to look at the popular GapMinder software of Rosling et al. (2018). This software shows human security indicators that sometimes start as early as in the year 1800. There is a button with 'data doubts'. The text is shown in Figure 5.1. Here, the third sentence notes that '*we still recommend to take these numbers with a large grain of salt*.' Whether such uncertain data should be provided at all, is something that is debatable in our view.

Since direct uncertainty information is generally lacking, we looked for indicators that might show how reliable statistical information is, for certain countries. We could use such information to judge the uncertainty in *any* human security indicator coming from such a country. In general, data from countries in conflict or countries with low government

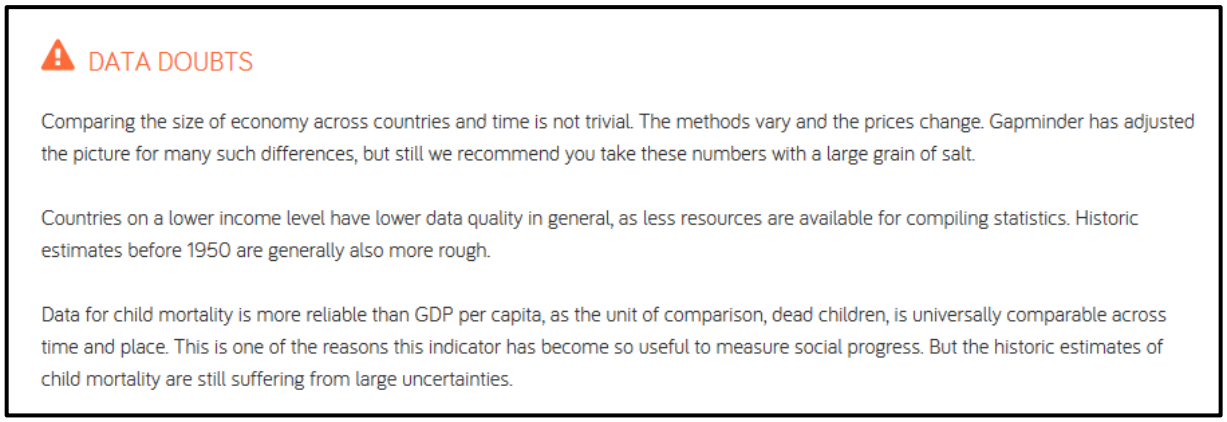


Figure 5.1 Data warning given in the GapMinder software of Rosling at al. (2018).

effectiveness are likely to be less reliable than data from rich countries without some form of insurgency or conflict.

We have summarised four of such reliability indicators in Table 5.1 (rows 2 to 5). The first indicator is taken from the Word Bank and is denoted as 'Statistical capacity'. It is a composite score assessing the capacity of a country's statistical system. The indicator is based on three areas: methodology, periodicity and timeliness, and varies between 0 (very unreliable) and 100 (very reliable). See Figure 5.2 showing indicator values for the year 2015 and plotted on a world map. A description is given in Box 5.1.

We note that this statistical capacity indicator applies especially to information supplied by individual countries. For perception data, based on international surveys — such as indicators for governance, corruption or happiness — the indicator will be less indicative. However, the distinction between 'internal data' and 'external data' will be vague in many occasions.

Other indicators suggested in the literature, are (i) to omit small countries (smaller than 500,000 inhabitants), (ii) to count the number of indicators with missing data or (iii) to follow the update speed of indicators.

Table 5.1 Indicators for quality assurance.

	Name of indicator	**Category**	**Source and year**
1	Indicator with coupled uncertainty indicators	Uncertainty indicators	World Bank, UCDP
2	Statistical capacity	Quality indicators	World bank
3	Countries with fewer than 500,000 inhabitants		World bank
4	Number of indicators with missing data		JRC
5	Indicator update speed, relative to 2016		JRC

Our approach in Part II of this study is to use the Statistical capacity indicator to show the reliability of countries by a colour coding from green (reliable) to red (unreliable). An example is given in Figure 5.3. Here we show a scatterplot for Governance on the x-axis and People with improved sanitation on the y-axis. Countries such as South Sudan or Afghanistan are coded in red, countries such as Ireland or Kuwait are coded in green.

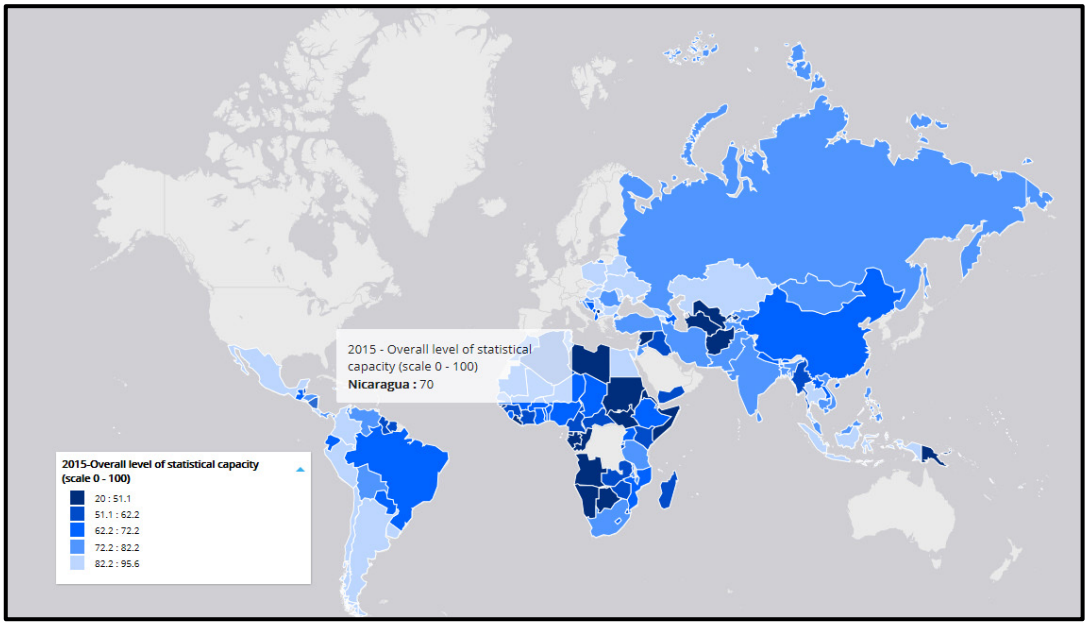


Figure 5.2 Statistical capacity (scale from 0 to 100). For individual countries, please see http://datatopics.worldbank.org/statisticalcapacity/SCIdashboard.aspx

Box 5.1 Metadata for the Statistical Capacity indicator. Source: World Bank.

Metadata: The Statistical Capacity Indicator is a composite score assessing the capacity of a country's statistical system. It is based on a diagnostic framework assessing the following areas: methodology; data sources; and periodicity and timeliness. Countries are scored against 25 criteria in these areas, using publicly available information and/or country input. The overall Statistical Capacity score is then calculated as a simple average of all three area scores on a scale of 0-100.

Source: World Bank. *Aggregation Method:* Unweighted average

Development Relevance: Statistical Capacity is a nation's ability to collect, analyze, and disseminate high-quality data about its population and economy. Quality statistics are essential for all stages of evidence-based decision-making, including: Monitoring social and economic indicators, Allocating political representation and government resources, Guiding private sector investment, as well as Informing the international donor community for program design and policy formulation.
Statistical Concept and Methodology: The Statistical Capacity Indicator score is calculated as the average of the scores of the 3 dimensions, i.e. Availability, Collection, Practice.

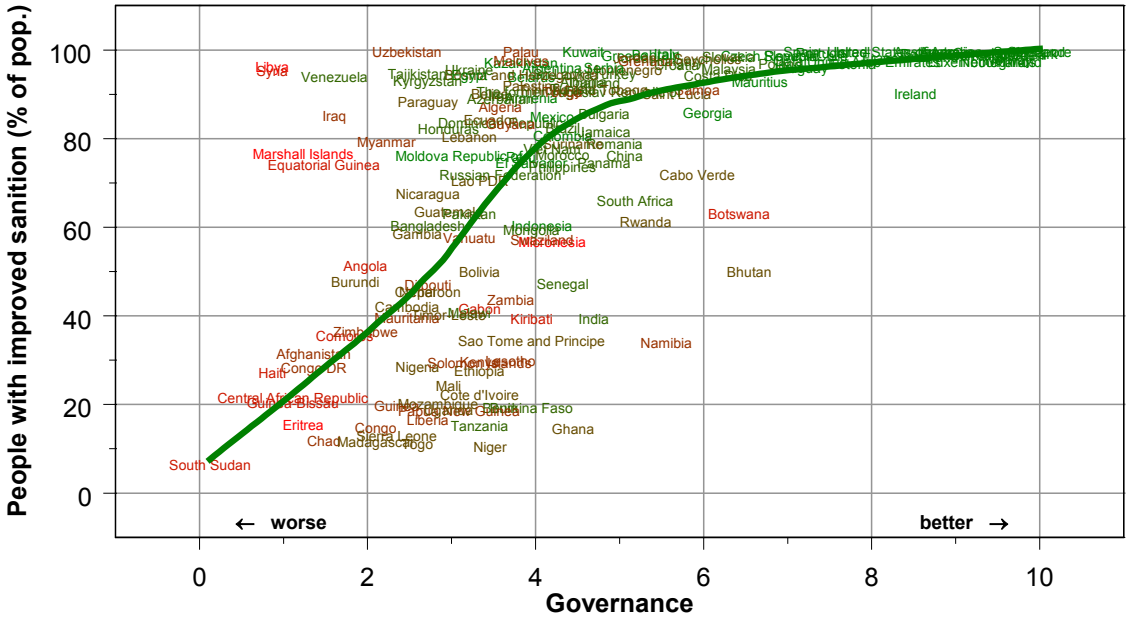


Figure 5.3 Scatterplot between Governance in 2016, taken from the INFORM database, and the number of people with improved sanitation, taken as percentage of the total population of a country. The colour coding from green to red corresponds to values of the World Bank statistical capacity indicator as shown in Figure 5.1 and Box 5.1.

5.2 Missing data

Studying the data sets described in Chapter 2, we see that, for many countries, indicators are missing data. Most institutes use a clear and consistent coding for missing data, such as N/A, -99, or just empty fields. However, countries **with data**, could have been missing in first instance. Or, in other words, the fact that a country has a number, does not always imply that it was measured.

For example, the Institute for Economics & Peace notes in their report (IEP, 2017, Appendix A) that they fill in data gaps on quantitative indicators when official data is missing. To do so, they employ more than 100 full-time country experts and economists, supported by 650 in-country contributors. However, if we look at their 23 indicators summarised in Table 2.3, we cannot know which countries have data and which countries have expert judgments.

The point we want to make here is that many data sets provide data that have a mixed qualitative and quantitative nature, depending on the country. And we do not have any information on which of the two situations we are dealing with. An unwanted situation in our view.

Missing data can also lead to erroneous databases if **missing data are set to zero**. In one version of the INFORM database we noticed that child mortality in Syria was zero, which is highly unlikely. Looking at the database in more detail and comparing estimates with earlier

versions of the INFORM database we found that most missing values were coded as zero, while zero was also an allowable number for most of the indicators. Note: this error was corrected by JRC shortly after publication of this specific database version.

A variation on filling in data gaps, occurs when composite indicators are formed. Suppose we have three indicators x_1, x_2 and x_3 that are the basis for composite indicator y following simple averaging scheme: $y_i = (x_{1,i} + x_{2,i} + x_{3,i}) / 3$, with index i a country number 1, ... , 191. If all three x values are present the composite indicator is easily computed. But what if one or two x-values are missing? As for the INFORM database we found that y_i is computed if at least one value is present where these x-variables are assumed to present similar information (JRC, 2017b, Section 6.1). For other databases it was unclear to us which decision was taken with respect to this issue.

This observation is relevant since the fact that indicator values are missing for a specific country, could point to countries with low statistical capacity and/or to extreme values for that specific indicator. Thus, composite indicators might have values that are too optimistic if composites y_i are calculated anyway.

5.3 Definitions and their interpretation

Another source of uncertainty comes from the fact that indicators or composite indicator are not clearly defined. Such definitions can be found in background reports or as metadata in spread sheets. For example, metadata for all 23 indicators given in Table 2.3 are summarised in an open access report (IEP, 2017, Appendix B). JRC publishes metadata for their INFORM database in a separate sheet in the Excel file which summarises their 53 indicators (Table 2.4B). The Word Bank gives extensive metadata on their website for all indicators available (Table 2.2).

However, definitions become rather vague if composites are formed. Marre (2013) gives an overview of definitions for composites such as 'vulnerability', 'disasters' or 'risk'. To be more specific, she found 9 definitions in the literature for 'Adaptation', 8 definitions for 'Capacity', 15 definitions for 'Disaster', 8 definitions for 'Exposure', 14 definitions for 'Hazard', 31 definitions for 'Risk', and 39 definitions for 'Vulnerability'.

We do not have such a list for terms as 'Governance' or 'People affected by natural disasters'. However, the above list of Marre shows that it is important to check definitions (which, hopefully, are available). This is especially true if indicators are compared across institutes or used in statistical analyses such as we give in Part II of this study

Metadata for a number of indicators applied in Part II of this study are given in Appendix A. Next to that, definitions can be interpreted differently by individual countries yielding inconsistent indicator values. For example, the category 'people affected by weather-related disasters' may be filled differently by countries or reporting institutes, such as the Red Cross, since the term 'affected' is not clearly defined. Does it mean 'people who lost their homes and cannot return', or 'people who have to leave their home for more than a month', or more than six months or some other period? Are people who need psychiatric help also counted as 'affected'?

Another example is the intentional homicide indicator described in Section 2.2.7. Here, it is noted that any cross-national comparison should be conducted with caution, because there are differences in legal definitions of offences between countries, between methods of

offence counting and recording, and between shares of criminal offences that are not reported to the police or remain undetected by law enforcement authorities.

As an example, we checked two disaster impact indicators from two institutions: CRED and Munich Re (cf. Section 2.2.1). The first database is open access, while the second is not. Both indicators are averaged over the same sample period, namely 1996–2015. Results are shown in Figure 5.4.

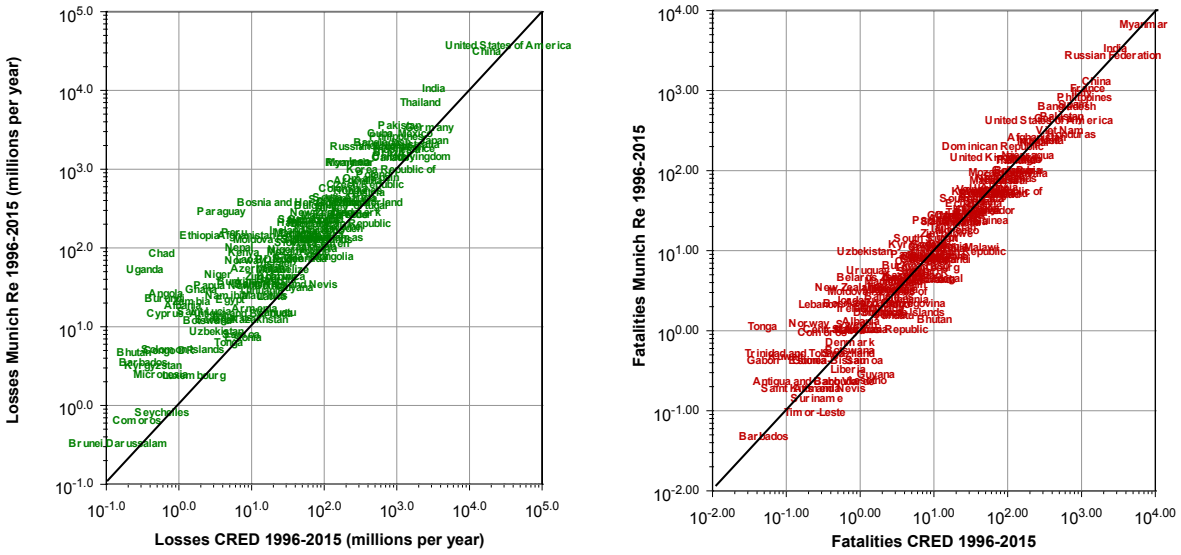


Figure 5.4 Total economic losses (left panel) and annual averaged number of people killed (right panel) for two databases: EM-DAT from CRED and NatCat from Munich Re (cf. Section 2.2.1). Sample period in both cases: 1996–2015.

The left-hand panel of Figure 5.4 shows that Munich Re estimates economic damage to be higher (all country data above the 1-to-1 line). Next to that the relationship is linear if both indicator estimates are plotted on a log scale. That means that the original loss data are related with an exponential.

The right-hand panel shows the relationship for people killed or 'fatalities'. Now the data are close around the 1-to-1 line, showing a linear relationship on both a log and a linear scales.

From this comparison, we conclude that both databases yield similar results where Munich Re estimates economic damage to be higher (variables shown on a log–log scale).

5.4 Temporal positioning

Varying time delays

If we analyse the Global Peace Index for the year 2017, one might think that all 23 sub-indicators, listed in Table 2.3, are for year 2017 too. Otherwise, the claim of having a composite indicator for the year 2017 would be incorrect. However, many indicator values are gathered with a (huge) time delay. And this time delay will vary considerately across countries. This aspect is reflected in the 'Indicator update speed up' given in the fifth row of Table 5.1.

Therefore, it is important to know exact years for which indicators are representative. Many institutes are not open with to this respect. A good positive example is given by the INFORM database. The Excel database contains a sheet with years for which all their 53 indicators are representative, filled in for all 191 countries. See Table 5.2. The table shows that years vary across indicators (the upper row), or across countries (e.g. the column for 'Adult literacy rate').

Knowledge of temporal positioning is important if indicators are compared across institutes or applied in statistical analyses. However, we note that temporal positioning plays a minor role, *in general,* since many indicators vary slowly and smoothly over time, as argued in Section 4.1 (cf. Figures 4.1a and 4.1B). The only exception will be if countries get involved in conflicts, severe insurgency, regime shifts or hit by natural disasters, all leading to political and socio-economic shocks and instabilities.

Table 5.2 Part of the Excel spreadsheet 'Indicator Date' of INFORM.

INFORM
INDEX FOR RISK MANAGEMENT

COUNTRY	ISO3	Average Dietary Energy Supply Adequacy	Prevalence of Undernourishment	Domestic Food Price Level Index	Domestic Food Price Volatility Index	HFA Scores Last recent	Government Effectiveness	Corruption Perception Index	Access to electricity	Adult literacy rate	Internet users	Mobile cellular subscriptions	Road lenght
Reference Year		*2014*	*2014*	*2014*	*2014*	*2015*	*2015*	*2016*	*2012*	*2014*	*2015*	*2015*	*2014*
Afghanistan	AFG	2014	2014			2015	2015	2016	2012	2011	2015	2015	2014
Albania	ALB	2014	2014	2014	2014		2015	2016	2012	2012	2015	2015	2014
Algeria	DZA	2014	2014	2014	2014	2011	2015	2016	2012	2006	2015	2015	2014
Angola	AGO	2014	2014	2013	2013	2007	2015	2016	2012	2013	2015	2015	2014
Antigua and Barbuda	ATG	2014	2014	2014		2009	2015		2012	2013	2015	2015	2014
Argentina	ARG	2014	2014			2015	2015	2016	2012	2013	2015	2015	2014
Armenia	ARM	2014	2014	2014	2014	2011	2015	2016	2012	2011	2015	2015	2014
Australia	AUS	2014	2014	2014		2015	2015	2016	2012		2015	2015	2014
Austria	AUT	2014	2014	2014	2014	2015	2015	2016	2012		2015	2015	2014
Azerbaijan	AZE	2014	2014				2015	2016	2012	2014	2015	2015	2014
Bahamas	BHS	2014	2014	2014	2014		2015	2016	2012		2015	2015	2014
Bahrain	BHR	2014	2014	2014	2014	2011	2015	2016	2012	2010	2015	2015	2014
Bangladesh	BGD	2014	2014	2014	2014	2015	2015	2016	2012	2013	2015	2015	2014
Barbados	BRB	2014	2014	2014	2014	2011	2015	2016	2012		2015	2015	2014
Belarus	BLR	2014	2014	2011		2015	2015	2016	2012	2009	2015	2015	2014
Belgium	BEL	2014	2014	2014	2014		2015	2016	2012		2015	2015	2014
Belize	BLZ	2014	2014	2011	2012		2015		2012		2015	2015	2014
Benin	BEN	2014	2014	2014	2014	2015	2015	2016	2012	2006	2015	2015	2014
Bhutan	BTN	2014	2014	2014	2014	2015	2015	2016	2012		2015	2015	2014
Bolivia	BOL	2014	2014	2014	2014	2011	2015	2016	2012	2012	2015	2015	2014
Bosnia and Herzegovina	BIH	2014	2014	2011	2012		2015	2016	2012	2013	2015	2015	2014

Lack of Coping Capacity | Indicator Data | Indicator Date | Indicator Source | Indicator Data imputation | Lack of Reliability Index | Indicator Meta ...

Some countries fall apart or unite
For some countries time series of indicator values become inconsistent since territories were split-up or united. We could not find texts on how organisations named in Chapters 2 and 3 deal with these inconsistencies. Various corrections are possible and may thus lead to differences between country statistics.

Examples are the falling apart of the Soviet Union in 1991, the breakup of Yugoslavia in 1992–1993, the breakup of Czechoslovakia into the Czech Republic and Slovakia in 1993, and the breakup of Sudan into Sudan and South Sudan in 2011. An example of unification is that of East and West Germany in 1990.

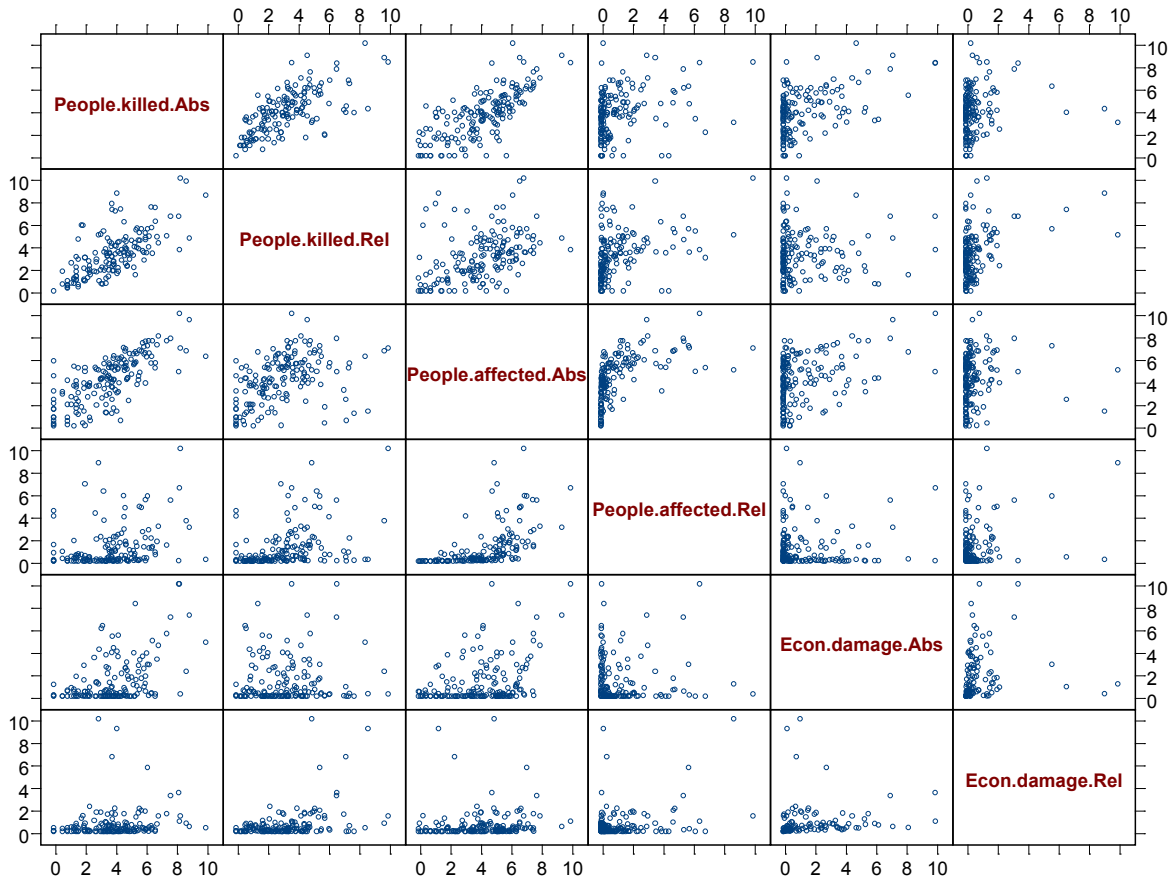
5.5 Indicators in absolute or relative terms, choice of impacts

Indicators can be presented in absolute terms or in relative terms. This holds for all indicators with a volume character, such as indicators starting with 'the number of people who', or indicators with an economic character, starting with 'economic damage by' or 'money spend to'. Thus, indicators such as 'the total number of people affected by floods', 'the number of homicides' or 'GDP PPP' can be given in absolute term or relative to the population size of each countries, leading to 'rates'. Next to that, economic indicators can be presented relative to the GDP of each country, such as 'Military spending' that is expressed as percentage of a country's GDP.

In general, indicators are given by researchers in terms of 'rates' or relative to GDP (or GDP PPP). Sometimes both absolute and relative indicators are given. However, it is not clear from an interpretational point of view what is more important: data in absolute terms or relative terms. For example, a large number of migrants, in absolute terms, might destabilise western countries and their mutual relationships (cf. recent discussions within the EU). Here, an indicator based on absolute numbers, has relevance.

To circumvent this problem, a number of indicators in the JRC INFORM database were calculated as a *combination* of 'absolute' and 'relative': first, both indicators are scaled from '0' to '10', and then simply averaged to form a new composite indicator, thus hoping to combine 'the best of two worlds'. The disadvantage of this approach is that the *socio-economic interpretation* is lost for this composite.

The patterns of indicators in absolute or relative terms can be quite different if shown for all countries in the world. An example is given in Figure 5.5A. Here we show three impacts of water-related disasters (= floods, droughts and tsunamis) in absolute and relative terms, in a scatterplot matrix, along with a correlation matrix. To diminish the role of outliers, indicators were log-transformed in this presentation.



	People.killed.Abs	People.killed.Rel	People.affected.Abs	People.affected.Rel	Econ.damage.Abs	Econ.damage.Rel
People.killed.Abs	1.00	0.80	0.82	0.39	0.54	0.24
People.killed.Rel	0.80	1.00	0.58	0.45	0.20	0.43
People.affected.Abs	0.82	0.58	1.00	0.58	0.43	0.16
People.affected.Rel	0.39	0.45	0.58	1.00	0.10	0.34
Econ.damage.Abs	0.54	0.20	0.43	0.10	1.00	0.24
Econ.damage.Rel	0.24	0.43	0.16	0.34	0.24	1.00

Figure 5.5A Scatterplot matrix for three impact factors of water-related disasters: people killed, people affected and economic damage. For each impact factor two version were calculated: absolute and relative.

The graph shows a reasonable correlation between 'the number of people killed' in absolute terms and relative terms: R= 0.80. However, correlations are much lower for 'the number of people affected': R= 0.58. The correlation for 'economic damage' is even lower: R= 0.24.

Figure 5.5A shows another important phenomenon: the correlations across these three impact indicators is low! As for indicators in relative form correlations are 0.34, 0.43 and 0.45. As for indicators in absolute form, correlations are somewhat higher: 0.34, 0.43 and 0.45.

An explanation has been given by Visser et al. (2014) who show that impacts of natural disasters are unevenly distributed over countries. This is illustrated in Figure 5.5B for countries aggregated to (i) OECD countries, (ii) the BRIICS countries and (iii) remaining developing countries. Next to that, patterns over time evolve quite differently.

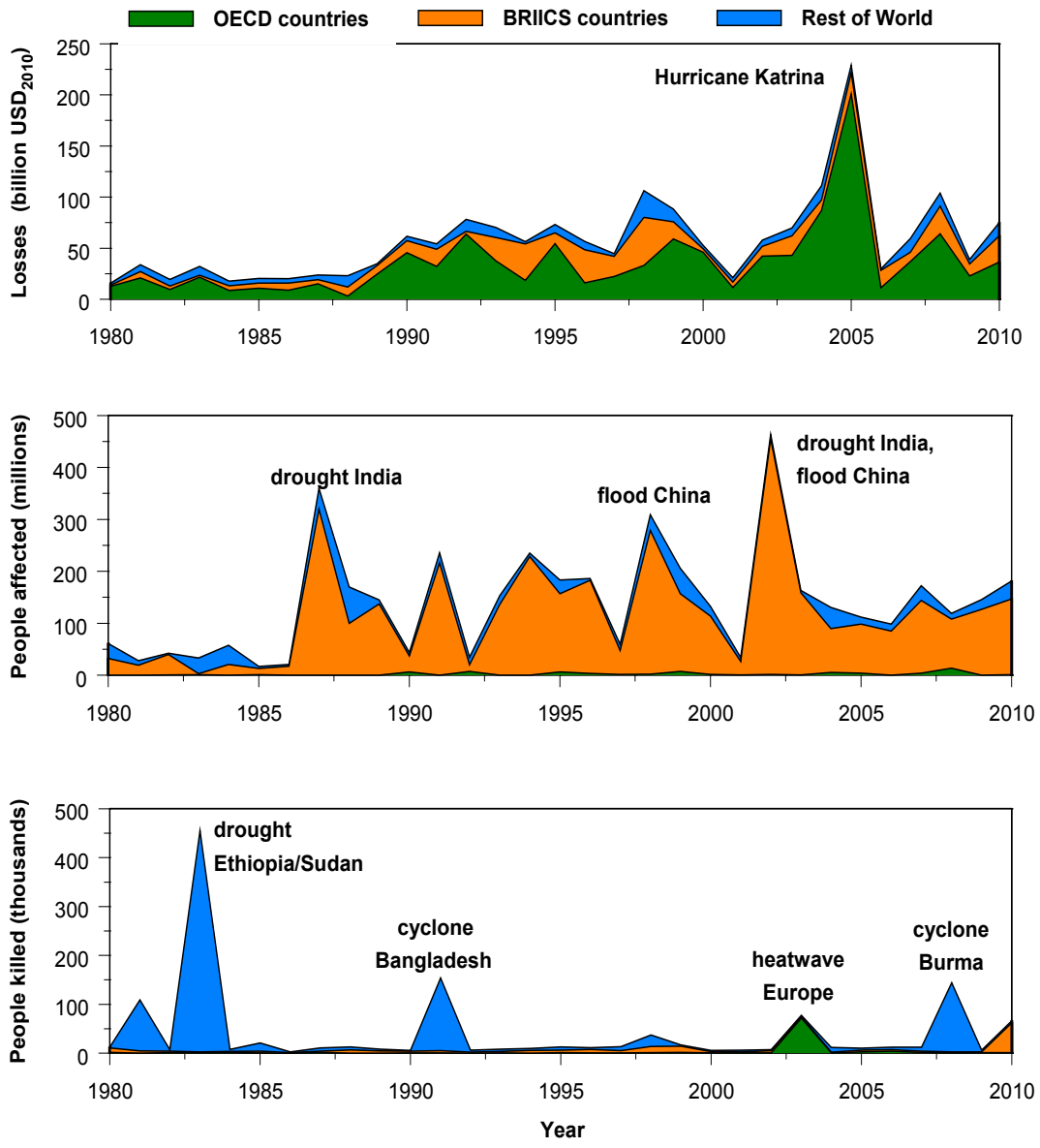


Figure 5.5B Three types of disaster impacts, stacked to three economic regions (OECD countries, BRIICS countries and Rest of World). The time evolution of economic losses is shown in upper panel, the number of people affected in the middle panel, and the number of people killed in the lower panel. Individual disasters with large impacts have been highlighted by catchwords. Disaster data have been aggregated from the CRED database EM-DAT. Source: Visser et al. (2014).

As a consequence, inferences on natural disasters should be treated with care. Which impacts are shown and/or analysed? For example, in the ODI briefing 'When disasters and conflicts collide' (Peters and Budimir, 2016), results are reported based on the absolute number of deaths per country: '58% of disaster deaths take place in the top 30 fragile states'. However, this conclusion highly depends on this specific choice of impact, expressed in absolute terms!

5.6 Composite indicators and uncertainties

We addressed a number of uncertainty sources that all deal with country statistics of one specific indicator. However, if indicators are combined to one new composite indicator, new sources of uncertainty arise. There are a wide range of methods available to calculate composite indicators (choice of an underlying theoretical framework, normalisation, choice of weights given to sub-indicators, aggregation, imputation of missing data).

All these choices influence the composite indicator presented. Details are not given here. We refer to Section 3.1, the JRC website COIN, Freudenberg (2003), Saisana et al. (2005) and JRC-OECD (2008). We only highlight one aspect, here, namely that of the development of a theoretical framework. Freudenberg formulates the importance as follows:

> A theoretical framework is needed to combine individual indicators into a meaningful composite and to provide a basis for the selection of components and weights applied. Ideally, this framework will allow variables to be selected, combined and weighted in a manner which reflects the dimension or structure of the phenomenon being measured. The variables selected should carry relevant information about the core components and be based on a paradigm concerning the behaviour being analysed. It is this framework that indicates which variables to include and how to weigh them to reflect their relative importance in the overall composite. But as yet, the theoretical underpinning of most composite indicators is very underdeveloped [...].

Clearly, the choice of variables is subjective and value-laden to some extent. To explore this aspect, we compare the composite indicators summarised in Table 3.4 in the next chapter.

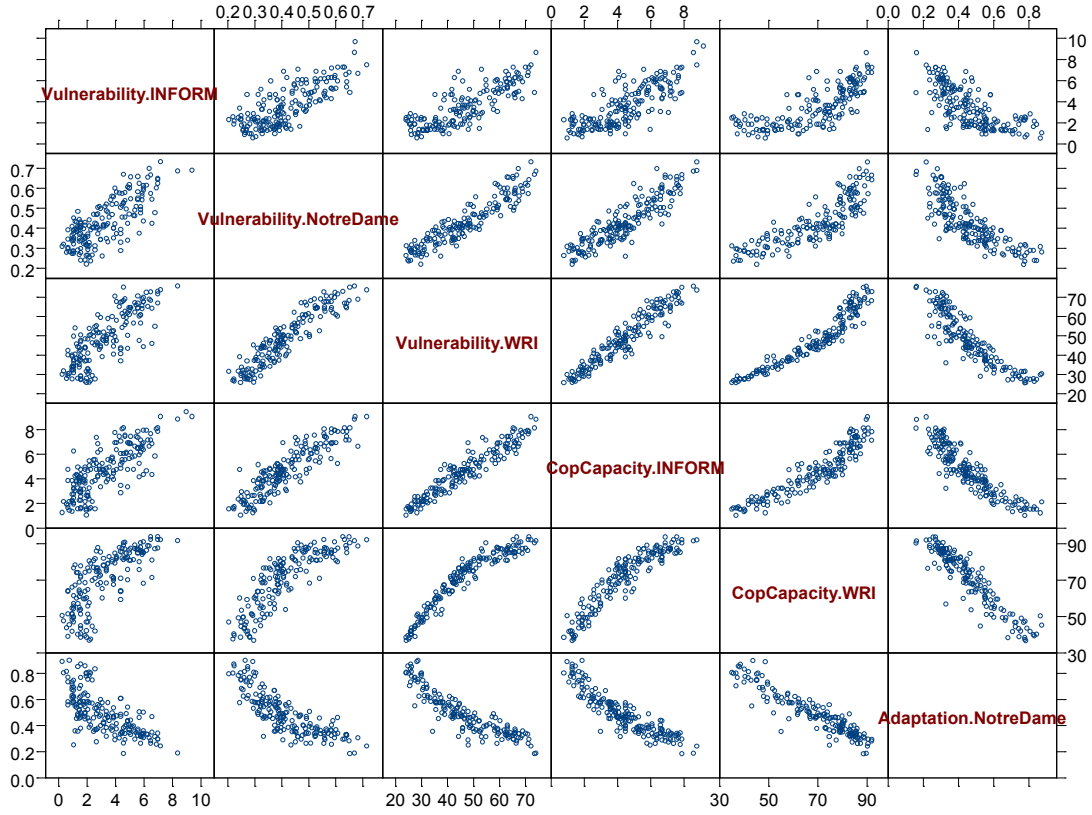
6 Composite indicators compared in a 'ring test'

Sections 5.1 through 5.6 have shown that indicators and composite indicators have uncertainties that are difficult to quantify in many occasions. This is especially true since most researchers or institutes present their data without any uncertainty bands and/or a limited amount of metadata.

In this section, we quantify the sum of all these uncertainty sources by comparing composite indicators across institutes *where the description of indicators suggests the same information*. To do so, we follow the list of composite indicators given in Table 3.4. This yields five comparisons, in the same style as laboratories do in so-called ring tests.

The first comparison is for ***vulnerability, coping capacity and adaptation***, as summarised in rows 1A through 1F of Table 3.4. These indicators are compared in Figure 6.1, along with a correlation matrix.

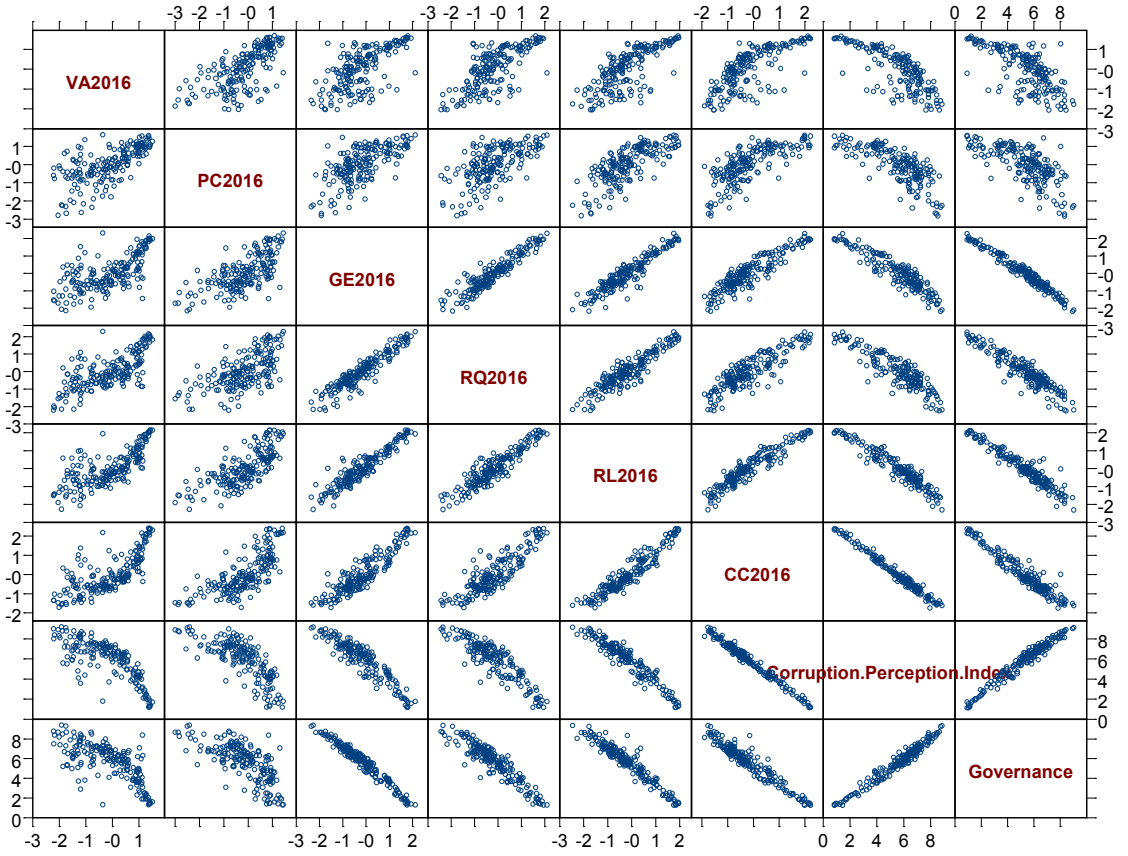
The graph shows that relationships are mainly linear or sometimes slightly parabolic. The parabolic shape might originate from the fact that some institutes used log-transformations for sub-indicators, and others did not. In addition, correlations are high:
$0.67 \leq |R| \leq 0.95$. Thus, results across countries are quite close, despite differences in definitions, treatment of missing data, and methods of aggregation.



	Vulnerability.INFORM	Vulnerability.NotreDame	Vulnerability.WRI	CopCapacity.INFORM	CopCapacity.WRI	Adaptation.NotreDame
Vulnerability.INFORM	1.00	0.75	0.78	0.80	0.72	-0.67
Vulnerability.NotreDame	0.75	1.00	0.93	0.89	0.85	-0.81
Vulnerability.WRI	0.78	0.93	1.00	0.95	0.94	-0.91
CopCapacity.INFORM	0.80	0.89	0.95	1.00	0.92	-0.88
CopCapacity.WRI	0.72	0.85	0.94	0.92	1.00	-0.95
Adaptation.NotreDame	-0.67	-0.81	-0.91	-0.88	-0.95	1.00

Figure 6.1 Scatterplot matrix and correlations for vulnerability/coping capacity/adaptation indicators, as summed up in Table 3.4.

Second, we compared ***governance and corruption indicators*** as summarised in rows 2A, 2B and 2C. These indicators are shown in Figure 6.2. Again, the graph shows linear relationships and high correlations: 0.63 ≤ | R | ≤ 0.98.



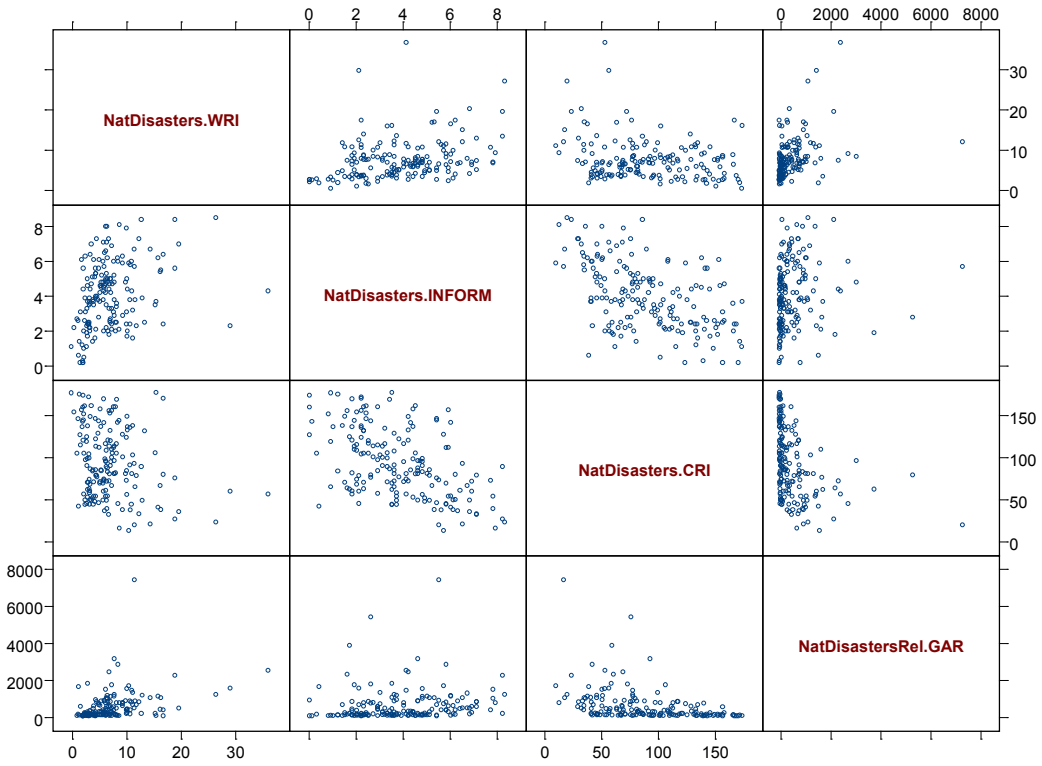
	VA2016	PC2016	GE2016	RQ2016	RL2016	CC2016	orruption.Perception.Inde	Governance
VA2016	1.00	0.67	0.66	0.72	0.75	0.74	-0.77	-0.70
PC2016	0.67	1.00	0.67	0.63	0.75	0.74	-0.76	-0.70
GE2016	0.66	0.67	1.00	0.94	0.94	0.91	-0.94	-0.98
RQ2016	0.72	0.63	0.94	1.00	0.92	0.87	-0.91	-0.93
RL2016	0.75	0.75	0.94	0.92	1.00	0.95	-0.98	-0.96
CC2016	0.74	0.74	0.91	0.87	0.95	1.00	-1.01	-0.97
Corruption.Perception.Index	-0.77	-0.76	-0.94	-0.91	-0.98	-1.01	1.00	1.00
Governance	-0.70	-0.70	-0.98	-0.93	-0.96	-0.97	1.00	1.00

Figure 6.2 Scatterplot matrix and correlations for governance/corruption indicators, as summed up in Table 3.4. World Bank indicators have minimum values of -2.5 (low level of governance) and +2.5 (high level). The JRC indicator 'Governance' is based on GE2016 and the Corruption Perception indicator.

Third, we compared indicators for ***natural disasters*** as summarised in rows 3A through 3D. Indicators are shown in Figure 6.3. Now, the results are quite different: only some *weak* linear relationships are found, along with low correlations: 0.15 ≤ | R | ≤ 0.52.

These differences can be explained by a number of factors, such as a varying choice of disaster categories, varying impacts (people killed, people affected, economic damage, as shown in Figure 5.2B), varying databases where underlying indicators are selected from, varying time positioning of impacts, varying sampling periods, varying choices for indicators in absolute or relative terms, and varying aggregation techniques.

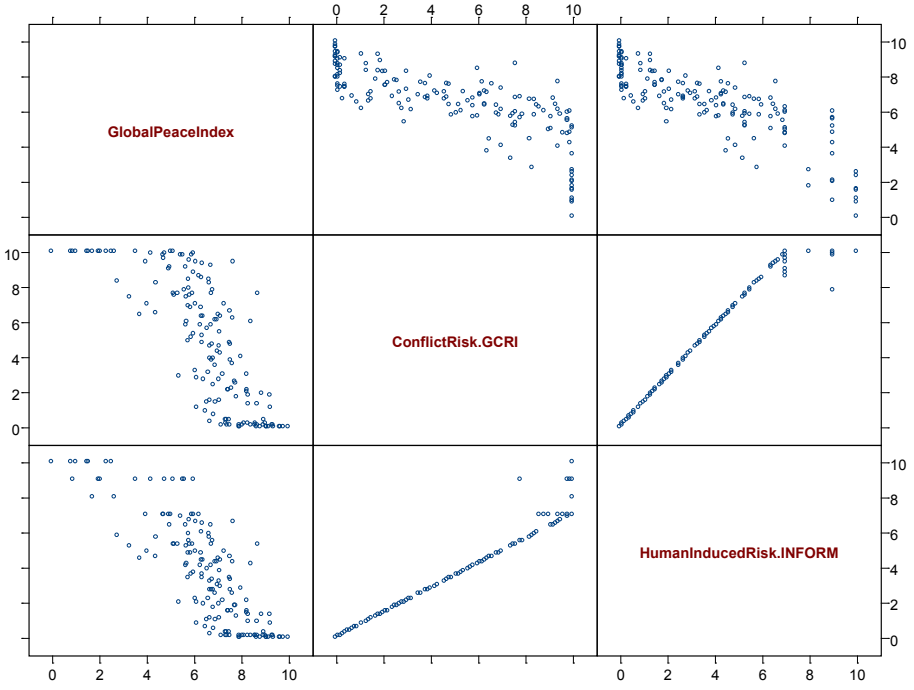
As an example, we name natural disasters as published by UNISDR in the GAR study (Section 3.2.4 and Noy, 2014) versus the version of INFORM. UNISDR expresses all disaster impacts in comparable terms and aggregates them into one new indicator. However, the INFORM composite combines model-based estimates for earthquake or tropical cycle impacts, both expressed in absolute and relative terms, along with frequencies of drought events and agricultural drought probabilities (indicators summed up in Table 2.4B). Thus, it will not come as a surprise that the correlation between these two indicators for natural disasters is low: **R = 0.15**.



	NatDisasters.WRI	NatDisasters.INFORM	NatDisasters.CRI	NatDisastersRel.GAR
NatDisasters.WRI	1.00	0.32	-0.25	0.32
NatDisasters.INFORM	0.32	1.00	-0.52	0.15
NatDisasters.CRI	-0.25	-0.52	1.00	-0.37
NatDisastersRel.GAR	0.32	0.15	-0.37	1.00

Figure 6.3 Scatterplot matrix and correlations for natural disasters, as summed up in Table 3.4.

Fourth, we compared indicators for ***conflict-related indicators*** as summarised in rows 5A, 5b and 5C of Table 3.4. Indicators are shown in Figure 6.4. The results show strong linear relationships with high correlations: 0.76 ≤ | R | ≤ 0.98. The pattern between the GCRI and INFORM indicator is explained by the fact that the GCRI indicator is a sub-indicator used in the INFORM version.

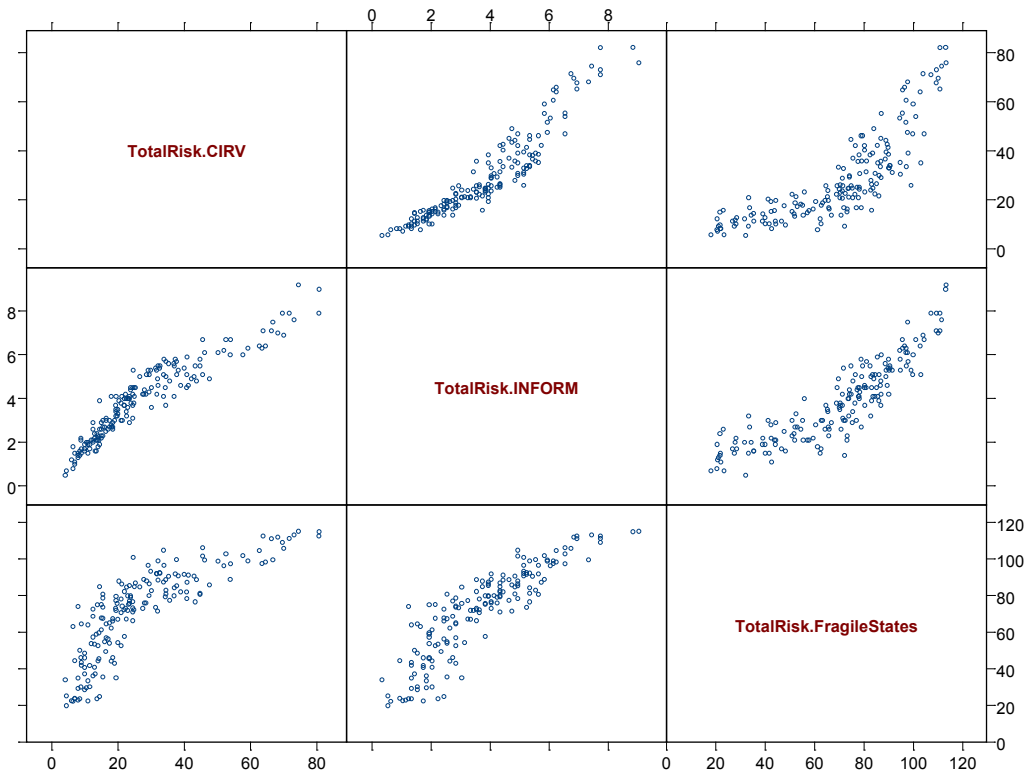


	GlobalPeaceIndex	ConflictRisk.GCRI	HumanInducedRisk.INFORM
GlobalPeaceIndex	1.00	-0.76	-0.82
ConflictRisk.GCRI	-0.76	1.00	0.98
HumanInducedRisk.INFORM	-0.82	0.98	1.00

Figure 6.4 Scatterplot matrix and correlations for conflict-related indicators, as summed up in Table 3.4. Values for the Global Peace Index lie between 0 and 10, with '10' meaning the highest level of peacefulness. The conflict risks from the GCRI and INFORM databases also run from 0 to 10 but with opposite meaning, with '10' meaning the highest level of conflict.

Finally, we compared indicators for ***total risks*** as summarised in rows 6A, 6b and 6C of Table 3.4. Here, 'total risk' stands for the combined risk of natural disasters, violence and conflicts, socio-economic vulnerability and coping capacity. Indicators are shown in Figure 6.5.

The results show surprising coherent patterns, varying form linear to parabolic relationships, along with high correlations: $0.84 \leq |R| \leq 0.94$. Here we note that the high correlation between the CIRV and INFORM risks is not surprising since the INFORM risk indicator is contained in the CIRV indicator (for 50%, as summarised in Table 3.2).



	TotalRisk.CIRV	TotalRisk.INFORM	TotalRisk.FragileStates
TotalRisk.CIRV	1.00	0.94	0.84
TotalRisk.INFORM	0.94	1.00	0.90
TotalRisk.FragileStates	0.84	0.90	1.00

Figure 6.5 Scatterplot matrix and correlations for total risk indicators, as given in Table 3.4.

7 Conclusions

We report on a study where a broad range of global databases are explored and quantitatively linked on country level, in order to analyse relationships between socio-economic indicators and climatic/weather indicators on the one hand and indicators for violence and conflict on the other hand. We present our findings in two parts.
Part I —reported here — gives an overview of indicators, indicator frameworks and related composites. Special attention is given to uncertainties attached to indicators and composites. Part II deals with the statistical analysis of these data in order to explore the drivers of violence and conflict in more detail. Here we apply correlation analysis and machine learning techniques to identify a hierarchy in conflict drivers.

Results in this Part I report are as follows. First, we present a wealth of indicators and indicator frameworks, published by a great variety of institutes and all in public domain (except one). We name—without being complete—databases on natural disasters (CRED, Munich Re, GermanWatch, UNISDR), indicators on food security and water (FAO), UN global population dynamics, indicators on economic development, corruption and governance (World Bank, Transparency International), world happiness perception data (Sustainable Development Solutions Network), conflict-related indicators (UCDP, the Institute for Economics & Peace), indicators for migration, refugees and displaced people (UNHCR, IDMC, UN-DESA, IOM), and human security indicators (INFORM database of the EU Joint Research Centre, the CERF risk indices of UN-OCHA, Fragile States indicators of the Fund for Peace).

Second, all these institutes and databases are briefly reviewed along with relevant metadata. Next to that we show how these indicators and indicator frameworks, all gathered on country basis, have been integrated into one database for 191 countries in the world, in line with the database set-up chosen by the JRC for their INFORM database. All software implementations are within the statistical package S-PLUS that is closely related to R.

Third, we address the reliability of indicators and related composites. Uncertainties in indicators originate from a wide range of sources. We discuss the following items:

- the treatment of missing country data varies from institute to institute. This involves the process of interpolation of missing indicator data (or the absence thereof), but also involves the aggregation process from sub-indicators to a composite (if 4 indicators are missing for country x, out of 10 indicators, is the composite indicator missing or the average of the remaining 6?),
- definitions of indicators may vary from institute to institute. And not all institutes are explicit in their definitions. Next to that, individual countries may interpret definitions differently yielding inconsistencies in indicator data ('the number of people affected by weather-related disasters' is rather vague since what is 'affected' exactly?),
- institutes may calculate and publish their indicators in absolute terms, relative terms (relative the population size or GDP), or both. Depending on the indicator, global patterns may show weak correlations (this is the case for impacts of weather-related disasters),

- the temporal positioning of indicators may vary across indicators and across countries within one indicator. This makes the exact positioning of composite indicators complex.
- there are a wide range of methods available to calculate composite indicators (choice of an underlying theoretical framework, normalisation, aggregation, imputation of missing data). All these choices influence the composite indicator presented.

Fourth, explicit uncertainties on indicator data on country scales are given only rarely (row 1 in the table below). As a way out, we propose four indicators that give general information on the statistical capacity of individual countries (rows 2–5):

	Name of indicator	**Category**	**Source and year**
1	Indicator with coupled uncertainty indicators	Uncertainty indicator	World Bank, UCDP
2	Statistical capacity	Quality indicators	World bank
3	Countries with fewer than 500,000 inhabitants		World bank / JRC
4	Number of indicators with missing data		JRC
5	Indicator update speed, relative to 2016		JRC

Fifth, we performed a 'ring test' for the composite indicators described in Chapter 3 (Table 3.4). These comparisons show how the range of uncertainty sources summed above, influence the global patterns of composites presented in the literature. It is found that correlations between composites of varying institutes are high for 'vulnerability/coping capacity/adaption', high for 'governance/corruption', very low for 'impacts of natural disasters', reasonably high for conflict-related composites, and high for human security total risk indicators.

Low correlations for impacts of natural disasters can be explained from deviating choices made by institutes as for specific disaster impacts (people affected, people killed and/or economic damage), in combination with absolute or relative impact measures (i.e., impacts relative to population size or GDP). It is illustrated in Figure 5.5B how the various impacts are unequally distributed over the globe.

In the second part of this study — on statistical analyses concerning human security and conflicts — we use the statistical capacity indicator to highlight uncertainties in statistical inferences.

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Appendix A: Metadata for World Bank indicators

A.1 Agricultural land (% of land area), data for the year 2015

Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as 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. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.

Source: Food and Agriculture Organization, electronic files and web site.

Development Relevance: Agricultural land covers more than one-third of the world's land area, with arable land representing less than one-third of agricultural land (about 10 percent of the world's land area). Agricultural land constitutes only a part of any country's total area, which can include areas not suitable for agriculture, such as forests, mountains, and inland water bodies. In many industrialized countries, agricultural land is subject to zoning regulations. In the context of zoning, agricultural land (or more properly agriculturally zoned land) refers to plots that may be used for agricultural activities, regardless of the physical type or quality of land. FAO's agricultural land data contains a wide range of information on variables that are significant for: understanding the structure of a country's agricultural sector; making economic plans and policies for food security; deriving environmental indicators, including those related to investment in agriculture and data on gross crop area and net crop area which are useful for policy formulation and monitoring. There is no single correct mix of inputs to the agricultural land, as it is dependent on local climate, land quality, and economic development; appropriate levels and application rates vary by country and over time and depend on the type of crops, the climate and soils, and the production process used.

Limitations and Exceptions: The data are collected by the Food and Agriculture Organization of the United Nations (FAO) from official national sources through annual questionnaires and are supplemented with information from official secondary data sources. The secondary sources cover official country data from websites of national ministries, national publications and related country data reported by various international organizations.. The FAO tries to impose standard definitions and reporting methods, but complete consistency across countries and over time is not possible. Thus, data on agricultural land in different climates may not be comparable. For example, permanent pastures are quite different in nature and intensity in African countries and dry Middle Eastern countries. Data on agricultural employment, in particular, should be used with caution. In many countries much agricultural employment is informal and unrecorded, including substantial work performed by women and children. To address some of these concerns, this indicator is heavily footnoted in the database in sources, definition, and coverage.

Statistical Concept and Methodology: Agriculture is still a major sector in many economies, and agricultural activities provide developing countries with food and revenue. But agricultural activities also can degrade natural resources. Poor farming practices can cause soil erosion and loss of soil fertility. Efforts to increase productivity by using chemical fertilizers, pesticides, and intensive irrigation have environmental costs and health impacts. Excessive use of chemical fertilizers can alter the chemistry of soil. Pesticide poisoning is common in developing countries. And salinization of irrigated land diminishes soil fertility. Thus, inappropriate use of inputs for agricultural production has far-reaching effects. Agricultural land is also sometimes classified as irrigated and non-irrigated land. In arid and semi-arid countries agriculture is often confined to irrigated land, with very little farming possible in non-irrigated areas. Land abandoned as a result of shifting cultivation is excluded from Arable land. Data on agricultural land are valuable for conducting studies on a various perspectives concerning agricultural production, food security and for deriving cropping intensity among others uses. Agricultural land indicator, along with land-use indicators, can also elucidate the environmental sustainability of countries' agricultural practices. Total land area does not include inland water bodies such as major rivers and lakes. Variations from year to year may be due to updated or revised data rather than to change in area.

A.2 Annual freshwater withdrawals, agriculture (% of total freshwater withdrawal), data for the year 2015

Annual freshwater withdrawals refer to total water withdrawals, not counting evaporation losses from storage basins. Withdrawals also include water from desalination plants in countries where they are a significant source. Withdrawals can exceed 100 percent of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable or where there is significant water reuse. Withdrawals for agriculture are total withdrawals for irrigation and livestock production. Data are for the most recent year available for 1987-2002.

Source: Food and Agriculture Organization, AQUASTAT data.

Development Relevance: While some countries have an abundant supply of fresh water, others do not have as much. UN estimates that many areas of the world are already experiencing stress on water availability. Due to the accelerated pace of population growth and an increase in the amount of water a single person uses, it is expected that this situation chapter
continue to get worse. The ability of developing countries to make more water available for domestic, agricultural, industrial and environmental uses will depend on better management of water resources and more cross-sectoral planning and integration. According to World Water Council, by 2020, water use is expected to increase by 40 percent, and 17 percent more water will be required for food production to meet the needs of the growing population. The three major factors causing increasing water demand over the past century are population growth, industrial development and the expansion of irrigated agriculture.

There is now ample evidence that increased hydrologic variability and change in climate has and will continue to have a profound impact on the water sector through the hydrologic cycle, water availability, water demand, and water allocation at the global, regional, basin, and local levels. Properly managed water resources are a critical component of growth, poverty reduction and equity. The livelihoods of the poorest are critically associated with access to water services. A shortage of water in the future would be detrimental to the human population as it would affect everything from sanitation, to overall health and the production of grain. Freshwater use by continents is partly based on several socio-economic development factors, including population, physiography, and climatic characteristics. It is estimated that in the coming decades the most intensive growth of water withdrawal is expected to occur in Africa and South America (increasing by 1.5-1.6 times), while the smallest growth will take place in Europe and North America (1.2 times).

Limitations and Exceptions: A common perception is that most of the available freshwater resources are visible (on the surfaces of lakes, reservoirs and rivers). However, this visible water represents only a tiny fraction of global freshwater resources, as most of it is stored in aquifers, with the largest stocks stored in solid form in the Antarctic and in Greenland's ice cap. The data on freshwater resources are based on estimates of runoff into rivers and recharge of groundwater. These estimates are based on different sources and refer to different years, so cross-country comparisons should be made with caution. Because the data are collected intermittently, they may hide significant variations in total renewable water resources from year to year. The data also fail to distinguish between seasonal and geographic variations in water availability within countries.

Data for small countries and countries in arid and semiarid zones are less reliable than those for larger countries and countries with greater rainfall. Caution should also be used in comparing data on annual freshwater withdrawals, which are subject to variations in collection and estimation methods. In addition, inflows and outflows are estimated at different times and at different levels of quality and precision, requiring caution in interpreting the data, particularly for water-short countries, notably in the Middle East and North Africa. The data are based on surveys and estimates provided by governments to the Joint Monitoring Programme of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). The coverage rates are based on information from service users on actual household use rather than on information from service providers, which may include nonfunctioning systems.

Statistical Concept and Methodology: This indicator measures the pressure on the renewable water resources of a country caused by irrigation. According to Commission on Sustainable Development (CSD) agriculture accounts for more than 70 percent of freshwater drawn from lakes, rivers and underground sources. Most is used for irrigation which provides about 40 percent of the world food production. Poor management has resulted in the salinization of about 20 percent of the world's irrigated land, with an additional 1.5 million ha affected annually. Water withdrawals can exceed 100 percent of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable or where water reuse is significant. Withdrawals for agriculture and industry are total withdrawals for irrigation and livestock production and for direct industrial use (including for cooling thermoelectric plants).

A.3 Energy imports, net (% of energy use), data for the year 2015

Net energy imports are estimated as energy use less production, both measured in oil equivalents. A negative value indicates that the country is a net exporter. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

Source: IEA Statistics © OECD/IEA 2014 (iea.org/stats/index.asp), subject to iea.org/t&c/termsandconditions

Development Relevance: Modern energy services are crucial to a country's economic development. Access to modern energy is essential for the provision of clean water, sanitation and healthcare and for the provision of reliable and efficient lighting, heating, cooking, mechanical power, and transport and telecommunications services. Governments in many countries are increasingly aware of the urgent need to make better use of the world's energy resources. Improved energy efficiency is often the most economic and readily available means of improving energy security and reducing greenhouse gas emissions.
General Comments: Restricted use: Please contact the International Energy Agency for third-party use of these data.

Limitations and Exceptions: The IEA makes these estimates in consultation with national statistical offices, oil companies, electric utilities, and national energy experts. The IEA occasionally revises its time series to reflect political changes, and energy statistics undergo continual changes in coverage or methodology as more detailed energy accounts become available. Breaks in series are therefore unavoidable.

Statistical Concept and Methodology: Energy data are compiled by the International Energy Agency (IEA). IEA data for economies that are not members of the Organisation for Economic Co-operation and Development (OECD) are based on national energy data adjusted to conform to annual questionnaires completed by OECD member governments. A negative value in energy imports indicates that the country is a net exporter. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

A.4 Forest area (% of land area), data for the year 2015

Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.

Source: Food and Agriculture Organization, electronic files and web site.
Development Relevance: As threats to biodiversity mount, the international community is increasingly focusing on conserving diversity. Deforestation is a major cause of loss of biodiversity, and habitat conservation is vital for stemming this loss. Conservation efforts have focused on protecting areas of high biodiversity. On a global average, more than one-third of all forest is primary forest, i.e. forest of native species where there are no clearly visible indications of human activities and the ecological processes have not been significantly disturbed. Primary forests, in particular tropical moist forests, include the most species-rich, diverse terrestrial ecosystems. The decrease of forest area, .11 percent over a ten-year period, is largely due to reclassification of primary forest to "other naturally regenerated forest" because of selective logging and other human interventions.

Destruction of rainforests remains a significant environmental problem Much of what remains of the world's rainforests is in the Amazon basin, where the Amazon Rainforest covers approximately 4 million square kilometers. The regions with the highest tropical deforestation rate are in Central America and tropical Asia. FAO estimates that the decrease of primary forest area, 0.4 percent over a ten-year period, is largely due to reclassification of primary forest to "other naturally regenerated forest" because of selective logging and other human interventions. Large-scale planting of trees is significantly reducing the net loss of forest area globally, and afforestation and natural expansion of forests in some countries and regions have reduced the net loss of forest area significantly at the global level. Forests cover about 31 percent of total land area of the world; the world's total forest area is just over 4 billion hectares. On a global average, more than one-third of all forest is primary forest, i.e. forest of native species where there are no clearly visible indications of human activities and the ecological processes have not been significantly disturbed.

Primary forests, in particular tropical moist forests, include the most species-rich, diverse terrestrial ecosystems. National parks, game reserves, wilderness areas and other legally established protected areas cover more than 10 percent of the total forest area in most countries and regions. FAO estimates that around 10 million people are employed in forest management and conservation - but many more are directly dependent on forests for their livelihoods. Close to 1.2 billion hectares of forest are managed primarily for the production of wood and non-wood forest products. An additional 25 percent of forest area is designated for multiple uses - in most cases including the production of wood and non-wood forest products. The area designated primarily for productive purposes has decreased by more than 50 million hectares since 1990 as forests have been designated for other purposes.

Limitations and Exceptions: FAO has been collecting and analyzing data on forest area since 1946. This is done at intervals of 5-10 years as part of the Global Forest Resources Assessment (FRA). FAO reports data for 229 countries and territories; for the remaining 56 small island states and territories where no information is provided, a report is prepared by FAO using existing information and a literature search. The data are aggregated at sub-regional, regional and global levels by the FRA team at FAO, and estimates are produced by straight summation. The lag between the reference year and the actual production of data series as well as the frequency of data production varies between countries. Deforested areas do not include areas logged but intended for regeneration or areas degraded by fuelwood gathering, acid precipitation, or forest fires. Negative numbers indicate an increase in forest area.

Data includes areas with bamboo and palms; forest roads, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest; windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 hectares and width of more than 20 meters; plantations primarily used for forestry or protective purposes, such as rubber-wood plantations and cork oak stands. Data excludes tree stands in agricultural production systems, such as fruit plantations and agroforestry systems. Forest area also excludes trees in urban parks and gardens. The proportion of forest area to total land area is calculated and changes in the proportion are computed to identify trends.

Long Definition: Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.

Statistical Concept and Methodology: Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should reach a minimum height of 5 meters in situ. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10 percent and a tree height of 5 meters are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate. The Food and Agriculture Organization (FAO) provides detail information on forest cover, and adjusted estimates of forest cover. The survey uses a uniform definition of forest. Although FAO provides a breakdown of forest cover between natural forest and plantation for developing countries, forest data used to derive this indictor data does not reflect that breakdown. Total land area does not include inland water bodies such as major rivers and lakes. Variations from year to year may be due to updated or revised data rather than to change in area. The indictor is derived by dividing total area under forest of a country by country's total land area, and multiplying by 100.

A.5 Improved water source (% of population with access), data for the year 2015

Access to an improved water source refers to the percentage of the population using an improved drinking water source. The improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection).

Source: WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (wssinfo.org).

Development Relevance: Water is considered to be the most important resource for sustaining ecosystems, which provide life-supporting services for people, animals, and plants. Global access to safe water and proper hygiene education can reduce illness and death from disease, leading to improved health, poverty reduction, and socio-economic development. However, many countries are challenged to provide these basic necessities to their populations, leaving people at risk for water, sanitation, and hygiene (WASH)-related diseases. Because contaminated water is a major cause of illness and death, water quality is a determining factor in human poverty, education, and economic opportunities. Lack of access to adequate water contributes to deaths and illness, especially in children. Water based disease transmission by drinking contaminated water is responsible for significant outbreaks of diseases such as cholera and typhoid and include diarrhea, viral hepatitis A, cholera, dysentery and dracunculiasis (Guineaworm disease).

Improvement of access to clean drinking water is a crucial element in the reduction of under-five mortality and morbidity. Women and children spend millions of hours each year fetching water. The chore diverts their time from other important activities (for example attending school, caring for children, participating in the economy). When water is not available on premises and has to be collected, women and girls are almost two and a half times more likely than men and boys to be the main water carriers for their families. Many international organizations use access to safe drinking water and hygienic sanitation facilities as a measure for progress in the fight against poverty, disease, and death. Access to safe drinking water is also considered to be a human right, not a privilege, for every man, woman, and child. Economic benefits of improved drinking water include higher economic productivity, more education, and health-care savings.

Limitations and Exceptions: The data on access to an improved water source measure the percentage of the population with ready access to water for domestic purposes. Access to drinking water from an improved source does not ensure that the water is safe or adequate, as these characteristics are not tested at the time of survey. But improved drinking water technologies are more likely than those characterized as unimproved to provide safe drinking water

and to prevent contact with human excreta. While information on access to an improved water source is widely used, it is extremely subjective, and such terms as safe, improved, adequate, and reasonable may have different meanings in different countries despite official WHO definitions (see Definitions). Even in high-income countries treated water may not always be safe to drink. Access to an improved water source is equated with connection to a supply system; it does not take into account variations in the quality and cost (broadly defined) of the service.

Statistical Concept and Methodology: The data are derived by the Joint Monitoring Programme of the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) based on national censuses and nationally representative household surveys. The coverage rates for water and sanitation are based on information from service users on the facilities their households actually use rather than on information from service providers, which may include nonfunctioning systems. WHO/UNICEF define an improved drinking-water source as one that, by nature of its construction or through active intervention, is protected from outside contamination, in particular from contamination with fecal matter. Improved water sources include piped water into dwelling, plot or yard; piped water into neighbor's plot; public tap/standpipe; tube well/borehole; protected dug well; protected spring; and rainwater.

A.6 Improved sanitation facilities (% of population with access), data for the year 2015

Access to improved sanitation facilities refers to the percentage of the population using improved sanitation facilities. Improved sanitation facilities are likely to ensure hygienic separation of human excreta from human contact. They include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

Source: WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (wssinfo.org).

Development Relevance: Sanitation is fundamental to human development. Many international organizations use hygienic sanitation facilities as a measure for progress in the fight against poverty, disease, and death. Access to proper sanitation is also considered to be a human right, not a privilege, for every man, woman, and child. Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on people's health. Improved sanitation can reduce diarrheal disease, and can significantly lessen the adverse health impacts of other disorders responsible for death and disease among millions of children. Diarrhea and worm infections weaken children and make them more susceptible to malnutrition and opportunistic infections like pneumonia, measles and malaria. The combined effects of inadequate sanitation, unsafe water supply and poor personal hygiene are responsible for many of childhood deaths. Every year, the failure to tackle these deficits results in severe welfare losses - wasted time, reduced productivity, ill health, impaired learning, environmental degradation and lost opportunities. Fundamental behavior changes are required before the use of improved facilities and services can be integrated into daily life. Many hygiene behaviors and habits are formed in childhood and, therefore, school health and hygiene education programs are an important part of water and sanitation improvements.

Most basic sanitation technologies are not expensive to implement. However, those facing the problems of inadequate sanitation are rarely aware of either the origin of their ills, or the true costs of their deficit. As a result, in most of the developing countries those without sanitation are hard to convince of the need to invest scarce resources in sanitation facilities, or of the critical importance of changing long-held habits and unhygienic behaviors. Consequently, the people's representatives - governments and elected political leaders - rarely give sanitation or hygiene improvements the priority that is needed in order to tackle the massive sanitation deficit faced by the developing world. Children bear the brunt of sanitation-related impacts - their health, nutrition, growth, education, self-respect, and life opportunities suffers as a result of inadequate sanitation. Without improved sanitation, many of the current generation of children in developing countries are unlikely to develop to their full potential. Countries that don't take urgent action to redress sanitation deficiencies will find their future development and prosperity impaired.

Limitations and Exceptions: The data are derived by the Joint Monitoring Programme of the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) based on national censuses and nationally representative household surveys. The coverage rates for sanitation are based on information from service users on the facilities their households actually use rather than on information from service providers, which may include nonfunctioning systems.

Statistical Concept and Methodology: Data on access to sanitation are produced by the Joint Monitoring Programme of the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) based on national censuses and nationally representative household surveys. The coverage rates for water and sanitation are based on information from service users on the facilities their households actually use rather than on information from service providers, which may include nonfunctioning systems. An improved sanitation facility is defined as one that hygienically separates human excreta from human contact. Improved sanitation facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.

A.7 International migrant stock (total and as % of population), data for the year 2015

International migrant stock is the number of people born in a country other than that in which they live. It also includes refugees. The data used to estimate the international migrant stock at a particular time are obtained mainly from population censuses. The estimates are derived from the data on foreign-born population--people who have residence in one country but were born in another country. When data on the foreign-born population are not available, data on foreign population--that is, people who are citizens of a country other than the country in which they reside--are used as estimates. After the breakup of the Soviet Union in 1991 people living in one of the newly independent countries who were born in another were classified as international migrants. Estimates of migrant stock in the newly independent states from 1990 on are based on the 1989 census of the Soviet Union. For countries with information on the international migrant stock for at least two points in time, interpolation or extrapolation was used to estimate the international migrant stock on July 1 of the reference years. For countries with only one observation, estimates for the reference years were derived using rates of change in the migrant stock in the years preceding or following the single observation available. A model was used to estimate migrants for countries that had no data. *Source*: United Nations Population Division, Trends in Total Migrant Stock: 2008 Revision.

Development Relevance: Movement of people, most often through migration, is a significant part of global integration. Migrants contribute to the economies of both their host country and their country of origin. Yet reliable statistics on migration are difficult to collect and are often incomplete, making international comparisons a challenge. Global migration patterns have become increasingly complex in modern times, involving not just refugees, but also millions of economic migrants. In most developed countries, refugees are admitted for resettlement and are routinely included in population counts by censuses or population registers. But refugees and migrants, even if they often travel in the same way, are fundamentally different, and for that reason are treated very differently under modern international law. Migrants, especially economic migrants, choose to move in order to improve the future prospects of themselves and their families. Refugees have to move if they are to save their lives or preserve their freedom.

Limitations and Exceptions: In deriving the estimates, an international migrant was equated to a person living in a country other than that in which he or she was born. That is, the number of international migrants, also called the international migrant stock, would represent the number of foreign-born persons enumerated in the countries or areas constituting the world. However, because several countries lack data on the foreign-born, data on the number of foreigners, if available, were used instead as the basis of estimation. Consequently, the overall number of migrants in world regions or at the global level do not quite represent the overall number of foreign-born persons. The disintegration and reunification of countries causes discontinuities in the change of the international migrant stock. Because an international migrant is equated with a person who was born outside the country in which he or she resides, when a country disintegrates, persons who had been internal migrants because they had moved from one part of the country to another may become, overnight, international migrants without having moved at that time. Such changes introduce artificial but unavoidable discontinuities in the trend of the international migrant stock. The reunification of States also introduces discontinuities, but in the opposite direction.

Statistical Concept and Methodology: The basic data to estimate the international migrant stock were obtained mostly from population censuses held during the decennial rounds of censuses. Some of the data used were obtained from population registers and nationally representative surveys. In the majority of cases, the sources available had gathered information on the place of birth of the enumerated population, thus allowing for the identification of the foreign-born population. In estimating the international migrant stock, international migrants have been equated with the foreign-born whenever possible. In most countries lacking data on place of birth, information on the country of citizenship of those enumerated was available and was used as the basis for the identification of international migrants, thus effectively equating international migrants with foreign citizens. Among the 230 countries or areas that constituted the world in 2008, 91 percent had at least one data source on the international migrant stock, and of those 78 percent used the number of foreign-born persons as the basis for estimation. For about 18 percent of the countries, the number of international migrants was based on data regarding foreign citizens. There were nine countries with no information including China, the Democratic People's Republic of Korea, Eritrea and Somalia. For countries having information on the international migrant stock for at least two points in time, interpolation or extrapolation using an exponential growth rate was used to estimate the international migrant stock on 1 July of the reference years.

In some instances, the estimates were adjusted on the basis of other relevant information, including the size of the total population in the country, to ensure that the proportion of migrants in small populations did not increase to unacceptable levels. For all other countries with only one data source, estimates for the reference years were derived by assuming growth rates of the migrant stock in the years preceding or following the only data source available. For the nine countries or areas for which no information was available on the international migrant stock, a model, based on the general observation that the proportion of international migrants tends to be inversely related to the size of the total population, was used. After the breakup of the Soviet Union in 1991 people living in one of the newly independent countries who were born in another were classified as international migrants. Estimates of migrant stock in the newly independent states from 1990 on are based on the 1989 census of the Soviet Union.

A.8 Military expenditure (% of GDP), data for the year 2016

Military expenditures data from SIPRI are derived from the NATO definition, which includes all current and capital expenditures on the armed forces, including peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities. Such expenditures include military and civil personnel, including retirement pensions of military personnel and social services for personnel; operation and maintenance; procurement; military research and development; and military aid (in the military expenditures of the donor country). Excluded are civil defense and current expenditures for previous military activities, such as for veterans' benefits, demobilization, conversion, and destruction of weapons. This definition cannot be applied for all countries, however, since that would require much more detailed information than is available about what is included in military budgets and off-budget military expenditure items. (For example, military budgets might or might not cover civil defense, reserves and auxiliary forces, police and paramilitary forces, dual-purpose forces such as military and civilian police, military grants in kind, pensions for military personnel, and social security contributions paid by one part of government to another.)

Source: Stockholm International Peace Research Institute (SIPRI), Yearbook: Armaments, Disarmament and International Security.

Development Relevance: Although national defense is an important function of government and security from external threats that contributes to economic development, high military expenditures for defense or civil conflicts burden the economy and may impede growth. Data on military expenditures as a share of gross domestic product (GDP) are a rough indicator of the portion of national resources used for military activities and of the burden on the economy. Data on military expenditures as a share of gross domestic product (GDP) are a rough indicator of the portion of national resources used for military activities and of the burden on the economy. As an "input" measure military expenditures are not directly related to the "output" of military activities, capabilities, or security. Comparisons of military spending among countries should take into account the many factors that influence perceptions of vulnerability and risk, including historical and cultural traditions, the length of borders that need defending, the quality of relations with neighbors, and the role of the armed forces in the body politic.
General Comments: Data for some countries are based on partial or uncertain data or rough estimates.

Limitations and Exceptions: Data on military expenditures are not compiled using standard definitions and are often incomplete and unreliable due to countries' reluctance to disclose military information. Even in countries where the parliament vigilantly reviews budgets and spending, military expenditures and arms transfers rarely receive close scrutiny or full, public disclosure (see Ball 1984 and Happe and Wakeman-Linn 1994). However, the Stockholm International Peace Research Institute (SIPRI) has adopted a definition of military expenditure derived from the North Atlantic Treaty Organization's (NATO) former definition (in use until 2002; see Definitions). In the many cases where SIPRI cannot make independent estimates, it uses the national data provided. Because of the differences in definitions and the difficulty in verifying the accuracy and completeness of data, data on military expenditures are not always comparable across countries. However, SIPRI puts a high priority on ensuring that the data series for each country is comparable over time.
Periodicity: Annual

Statistical Concept and Methodology: SIPRI military expenditure data includes military and civil personnel, including retirement pensions and social services for military personnel; operation and maintenance; procurement; military research and development; and military aid (in the military expenditures of the donor country). Excluded are civil defense and current expenditures for previous military activities, such as for veterans' benefits, demobilization, and weapons conversion and destruction. This definition cannot be applied for all countries, however, since that would require more detailed information than is available about military budgets and off-budget military expenditures (for example, whether military budgets cover civil defense, reserves and auxiliary forces, police and paramilitary forces, and military pensions). SIPRI data for the most recent years include two types of estimate which apply to all countries: (a) figures for the most recent years are for adopted budgets, budget estimates or revised estimates, and are revised, more often than not, in subsequent years; and (b) the deflator used for the latest year in the series is an estimate SIPRI's primary source of military expenditure data is official data provided by national governments.

These data are derived from budget documents, defense white papers, and other public documents from official government agencies, including government responses to questionnaires sent by SIPRI, the UNODA, or the Organization for Security and Co-operation in Europe. Secondary sources include international statistics, such as those of NATO and the IMF's Government Finance Statistics Yearbook. Other secondary sources include country reports of the Economist Intelligence Unit, country reports by IMF staff, and specialist journals and newspapers. The data on military expenditures as a share of GDP are SIPRI estimates. The SIPRI military expenditure figures are presented on a calendar-year basis. The only exception is the USA, for which statistics report data on a fiscal-year basis. Calendar-year data are calculated on the assumption of an even rate of expenditure throughout the fiscal year. The ratio of military expenditure to GDP is calculated in domestic currency at current prices and for calendar years. The SIPRI military expenditure figures are presented on a calendar-year basis. The only exception is the USA, for which statistics report data on a fiscal-year basis. Calendar-year data are calculated on the assumption of an even rate of expenditure throughout the fiscal year.

A.9 Net migration, data for the years 2008-2012

Net migration is the net total of migrants during the period, that is, the total number of immigrants less the annual number of emigrants, including both citizens and noncitizens. Data are five-year estimates.

Source: United Nations Population Division, World Population Prospects.

Development Relevance: Movement of people, most often through migration, is a significant part of global integration. Migrants contribute to the economies of both their host country and their country of origin. Yet reliable statistics on migration are difficult to collect and are often incomplete, making international comparisons a challenge. Global migration patterns have become increasingly complex in modern times, involving not just refugees, but also millions of economic migrants. In most developed countries, refugees are admitted for resettlement and are routinely included in population counts by censuses or population registers. But refugees and migrants, even if they often travel in the same way, are fundamentally different, and for that reason are treated very differently under modern international law. Migrants, especially economic migrants, choose to move in order to improve the future prospects of themselves and their families. Refugees have to move if they are to save their lives or preserve their freedom.

Limitations and Exceptions: International migration is the component of population change most difficult to measure and estimate reliably. Thus, the quality and quantity of the data used in the estimation and projection of net migration varies considerably by country. Furthermore, the movement of people across international boundaries, which is very often a response to changing socio-economic, political and environmental forces, is subject to a great deal of volatility. Refugee movements, for instance, may involve large numbers of people moving across boundaries in a short time. For these reasons, projections of future international migration levels are the least robust part of current population projections and reflect mainly a continuation of recent levels and trends in net migration.

Periodicity: Annual

Statistical Concept and Methodology: The United Nations Population Division provides data on net migration and migrant stock. Because data on migrant stock is difficult for countries to collect, the United Nations Population Division takes into account the past migration history of a country or area, the migration policy of a country, and the influx of refugees in recent periods when deriving estimates of net migration. The data to calculate these estimates come from a variety of sources, including border statistics, administrative records, surveys, and censuses. When there is insufficient data, net migration is derived through the difference between the overall population growth rate and the rate of natural increase (the difference between the birth rate and the death rate) during the same period. Such calculations are usually made for intercensal periods. The estimates are also derived from the data on foreign-born population - people who have residence in one country but were born in another country. When data on the foreign-born population are not available, data on foreign population - that is, people who are citizens of a country other than the country in which they reside - are used as estimates.

A.10 Ores and metals exports (% of merchandise exports), data for the year 2016

Ores and metals comprise the commodities in SITC sections 27 (crude fertilizer, minerals nes); 28 (metalliferous ores, scrap); and 68 (non-ferrous metals).

Source: World Bank staff estimates through the WITS platform from the Comtrade database maintained by the United Nations Statistics Division.

Aggregation Method: Weighted average

General Comments: Merchandise export shares may not sum to 100 percent because of unclassified trade.

Limitations and Exceptions: Previous editions contained data based on the SITC revision 1. Data for earlier years in previous editions may differ because of the change in methodology. Concordance tables are available to convert data reported in one system to another.
Periodicity: Annual
Statistical Concept and Methodology: The classification of commodity groups is based on the Standard International Trade Classification (SITC) revision 3.

A.11 Population growth (annual %), data for the year 2015

Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage . Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.

Source: Derived from total population. Population source: (1) United Nations Population Division. World Population Prospects, (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United

Periodicity: Annual

Statistical Concept and Methodology: Total population growth rates are calculated on the assumption that rate of growth is constant between two points in time. The growth rate is computed using the exponential growth formula: r = ln(pn/p0)/n, where r is the exponential rate of growth, ln() is the natural logarithm, pn is the end period population, p0 is the beginning period population, and n is the number of years in between. Note that this is not the geometric growth rate used to compute compound growth over discrete periods. For information on total population from which the growth rates are calculated, see total population (SP.POP.TOTL).

A.12 Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population), data for the year 2015

Poverty headcount ratio at $1.90 a day is the percentage of the population living on less than $1.90 a day at 2011 international prices. As a result of revisions in PPP exchange rates, poverty rates for individual countries cannot be compared with poverty rates reported in earlier editions.

Source: World Bank, Development Research Group. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. Data for high-income economies are from the Luxembourg Income Study database. For mor

Development Relevance: The World Bank Group is committed to reducing extreme poverty to 3 percent or less, globally, by 2030. Monitoring poverty is important on the global development agenda as well as on the national development agenda of many countries. The World Bank produced its first global poverty estimates for developing countries for World Development Report 1990: Poverty (World Bank 1990) using household survey data for 22 countries (Ravallion, Datt, and van de Walle 1991). Since then there has been considerable expansion in the number of countries that field household income and expenditure surveys.

The World Bank's Development Research Group maintains a database that is updated annually as new survey data become available (and thus may contain more recent data or revisions) and conducts a major reassessment of progress against poverty every year. PovcalNet is an interactive computational tool that allows users to replicate these internationally comparable $1.90, $3.20 and $5.50 a day global, regional and country-level poverty estimates and to compute poverty measures for custom country groupings and for different poverty lines. The Poverty and Equity Data portal provides access to the database and user-friendly dashboards with graphs and interactive maps that visualize trends in key poverty and inequality indicators for different regions and countries. The country dashboards display trends in poverty measures based on the national poverty lines alongside the internationally comparable estimates, produced from and consistent with PovcalNet.

General Comments: The World Bank's internationally comparable poverty monitoring database now draws on income or detailed consumption data from more than one thousand six hundred household surveys across 164 countries in six regions and 25 other high income countries (industrialized economies). While income distribution data are published for all countries with data available, poverty data are published for low- and middle-income countries and countries eligible to receive loans from the World Bank (such as Chile) and recently graduated countries (such as Estonia). See PovcalNet (iresearch.worldbank.org/PovcalNet/WhatIsNew.aspx) for definitions of geographical regions and industrialized countries.

Limitations and Exceptions: Despite progress in the last decade, the challenges of measuring poverty remain. The timeliness, frequency, quality, and comparability of household surveys need to increase substantially, particularly in the poorest countries. The availability and quality of poverty monitoring data remains low in small states, countries with fragile situations, and low-income countries and even some middle-income countries. The low frequency and lack of comparability of the data available in some countries create uncertainty over the magnitude of poverty reduction. Besides the frequency and timeliness of survey data, other data quality issues arise in measuring household living standards. The surveys ask detailed questions on sources of income and how it was spent, which must be carefully recorded by trained personnel. Income is generally more difficult to measure accurately, and consumption comes closer to the notion of living standards. And income can vary over time even if living standards do not. But

consumption data are not always available: the latest estimates reported here use consumption data for about two-thirds of countries.

However, even similar surveys may not be strictly comparable because of differences in timing or in the quality and training of enumerators. Comparisons of countries at different levels of development also pose a potential problem because of differences in the relative importance of the consumption of nonmarket goods. The local market value of all consumption in kind (including own production, particularly important in underdeveloped rural economies) should be included in total consumption expenditure but may not be. Most survey data now include valuations for consumption or income from own production, but valuation methods vary.

Statistical Concept and Methodology: International comparisons of poverty estimates entail both conceptual and practical problems. Countries have different definitions of poverty, and consistent comparisons across countries can be difficult. Local poverty lines tend to have higher purchasing power in rich countries, where more generous standards are used, than in poor countries. Since World Development Report 1990, the World Bank has aimed to apply a common standard in measuring extreme poverty, anchored to what poverty means in the world's poorest countries. The welfare of people living in different countries can be measured on a common scale by adjusting for differences in the purchasing power of currencies. The commonly used $1 a day standard, measured in 1985 international prices and adjusted to local currency using purchasing power parities (PPPs), was chosen for World Development Report 1990 because it was typical of the poverty lines in low-income countries at the time. As differences in the cost of living across the world evolve, the international poverty line has to be periodically updated using new PPP price data to reflect these changes.

The last change was in October 2015, when we adopted $1.90 as the international poverty line using the 2011 PPP. Prior to that, the 2008 update set the international poverty line at $1.25 using the 2005 PPP. Poverty measures based on international poverty lines attempt to hold the real value of the poverty line constant across countries, as is done when making comparisons over time. The $3.20 poverty line is derived from typical national poverty lines in countries classified as Lower Middle Income. The $5.50 poverty line is derived from typical national poverty lines in countries classified as Upper Middle Income. Early editions of World Development Indicators used PPPs from the Penn World Tables to convert values in local currency to equivalent purchasing power measured in U.S dollars. Later editions used 1993, 2005, and 2011 consumption PPP estimates produced by the World Bank. The current extreme poverty line is set at $1.90 a day in 2011 PPP terms, which represents the mean of the poverty lines found in 15 of the poorest countries ranked by per capita consumption. The new poverty line maintains the same standard for extreme poverty - the poverty line typical of the poorest countries in the world - but updates it using the latest information on the cost of living in developing countries.

As a result of revisions in PPP exchange rates, poverty rates for individual countries cannot be compared with poverty rates reported in earlier editions. The statistics reported here are based on consumption data or, when unavailable, on income surveys. Analysis of some 20 countries for which income and consumption expenditure data were both available from the same surveys found income to yield a higher mean than consumption but also higher inequality. When poverty measures based on consumption and income were compared, the two effects roughly cancelled each other out: there was no significant statistical difference.

A.13 Refugee population by country or territory of asylum, data for the year 2016

Refugees are people who are recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized as refugees in accordance with the UNHCR statute, people granted refugee-like humanitarian status, and people provided temporary protection. Asylum seekers--people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers--are excluded. Palestinian refugees are people (and their descendants) whose residence was Palestine between June 1946 and May 1948 and who lost their homes and means of livelihood as a result of the 1948 Arab-Israeli conflict. Country of asylum is the country where an asylum claim was filed and granted.

Source: United Nations High Commissioner for Refugees (UNHCR), Statistical Yearbook and data files, complemented by statistics on Palestinian refugees under the mandate of the UNRWA as published on its website. Data from UNHCR are available online at: unhcr.org/statistics/populationdatabase.

Development Relevance: Movement of people, most often through migration, is a significant part of global integration. Migrants contribute to the economies of both their host country and their country of origin. Yet reliable statistics on migration are difficult to collect and are often incomplete, making international comparisons a challenge. In most developed countries, refugees are admitted for resettlement and are routinely included in population counts by censuses or population registers. Globally, the number of refugees at end 2010 was 10.55 million, including 597,300 people considered by UNHCR to be in a refugee-like situation; developing countries hosted 8.5 million refugees, or 80 percent of the global refugee population. Global migration patterns have become increasingly complex in modern times, involving not just refugees, but also millions of economic migrants. But refugees and

migrants, even if they often travel in the same way, are fundamentally different, and for that reason are treated very differently under modern international law. Migrants, especially economic migrants, choose to move in order to improve the future prospects of themselves and their families. Refugees have to move if they are to save their lives or preserve their freedom. They have no protection from their own state - indeed it is often their own government that is threatening to persecute them. If other countries do not let them in, and do not help them once they are in, then they may be condemning them to death - or to an intolerable life in the shadows, without sustenance and without rights.

Limitations and Exceptions: There are difficulties in collecting accurate statistics on refugees. Many refugees may not be aware of the need to register or may choose not to do so, and administrative records tend to overestimate the number of refugees because it is easier to register than to de-register. In addition, most industrialized countries lack a refugee register and are thus not in a position to provide accurate information on the number of refugees residing in their country. Many countries have registries that are only maintained at the local level, so the data is not centralized. Asylum-seekers are persons who have applied for asylum or refugee status, but who have not yet received a final decision on their application. A distinction should be made between the number of asylum-seekers who have submitted an individual request during a certain period ("asylum applications submitted") and the number of asylum-seekers whose individual asylum request has not yet been decided at a certain date ("backlog of undecided or pending cases").

Caution should therefore be exercised when interpreting data on asylum-seekers. The United Nations High Commissioner for Refugees (UNHCR) collects and maintains data on refugees, except for Palestinian refugees residing in areas under the mandate of the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). Registration is voluntary, and estimates by the UNRWA are not an accurate count of the Palestinian refugee population. The data shows estimates of refugees collected by the UNHCR, complemented by estimates of Palestinian refugees under the UNRWA mandate. Thus, the aggregates differ from those published by the UNHCR. Statistics concerning the former USSR have been reported under the Russian Federation, those concerning the former Czechoslovakia have been reported under the Czech Republic and those concerning the former Yugoslavia and 'Serbia and Montenegro' have been reported under Serbia. Since 2006, separate statistics are available for Serbia and for Montenegro. Prior to 2006, no separate statistics are available and both countries have been reported under Serbia.

Notes From Original Source: The refugee population category from 2007 onwards also includes people in a refugee-like situation, most of who were previously included in the Others of concern group. This sub-category is descriptive in nature and includes groups of persons who are outside their country or territory of origin and who face protection risks similar to those of refugees, but for whom refugee status has, for practical or other reasons, not been ascertained. Statistics concerning the former USSR have been reported under the Russian Federation, those concerning the former Czechoslovakia have been reported under the Czech Republic and those concerning the former Yugoslavia and 'Serbia and Montenegro' have been reported under Serbia. Since 2006, separate statistics are available for Serbia and for Montenegro. Prior to 2006, no separate statistics are available and both countries have been reported under Serbia.

Statistical Concept and Methodology: The United Nations High Commissioner for Refugees (UNHCR) collects and maintains data on refugees in their Statistical Online Population Database. The refugee data does not include Palestinian refugees residing in areas under the mandate of the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). However, the Palestinian refugees living outside the UNRWA areas of operation do fall under the responsibility of UNHCR and are thus included in the Statistical Online Population Database. Refugees are an important part of migrant stock. The refugee data refer to people who have crossed an international border to find sanctuary and have been granted refugee or refugee-like status or temporary protection. There are three main providers of refugee data: governmental agencies, UNHCR field offices and NGOs. Registrations, together with other sources - including estimates and surveys - are the main sources of refugee data. In the absence of Government estimates, UNHCR has estimated the refugee population in most industrialized countries, based on recognition of asylum-seekers.

Prior to 2007, resettled refugees were included in these estimates. Up to and including 2006, to ensure that the refugee population in countries that lack a refugee registry is reflected in the global statistics, the number of refugees was estimated by UNHCR based on the arrival of refugees through resettlement programmes and the individual recognition of refugees over a 10-year (Europe and, since 2006, the United States) or 5-year (the United States before 2006, Canada and Oceania) period. Starting with the 2007 data, the cut-off period has been harmonized and now covers a 10-year period for Europe and non-European countries. Resettled refugees, however, are excluded from the refugee estimates in all countries. The 2007-2011 refugee population category includes people in a refugee-like situation, most of who were previously included in the Others of concern group. This sub-category is descriptive in nature and includes groups of persons who are outside their country or territory of origin and who face protection risks similar to those of refugees, but for whom refugee status has, for practical or other reasons, not been ascertained. Asylum seekers - people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers - and internally displaced people - who are often confused with refugees - are not included in the data. Unlike refugees, internally displaced people remain under the protection of their own government, even if their reason for fleeing was similar to that of refugees. Palestinian refugees are people (and their descendants) whose residence was Palestine between June 1946 and May 1948 and who lost their homes and means of livelihood as a result of the 1948 Arab-Israeli conflict.

A.14 Refugee population by country or territory of origin, data for the year 2016

Refugees are people who are recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized as refugees in accordance with the UNHCR statute, people granted refugee-like humanitarian status, and people provided temporary protection. Asylum seekers--people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers--are excluded. Palestinian refugees are people (and their descendants) whose residence was Palestine between June 1946 and May 1948 and who lost their homes and means of livelihood as a result of the 1948 Arab-Israeli conflict. Country of origin generally refers to the nationality or country of citizenship of a claimant.

Source: United Nations High Commissioner for Refugees (UNHCR), Statistical Yearbook and data files, complemented by statistics on Palestinian refugees under the mandate of the UNRWA as published on its website. Data from UNHCR are available online at: unhcr.org/statistics/populationdatabase.

Development Relevance: Movement of people, most often through migration, is a significant part of global integration. Migrants contribute to the economies of both their host country and their country of origin. Yet reliable statistics on migration are difficult to collect and are often incomplete, making international comparisons a challenge. In most developed countries, refugees are admitted for resettlement and are routinely included in population counts by censuses or population registers. Globally, the number of refugees at end 2010 was 10.55 million, including 597,300 people considered by UNHCR to be in a refugee-like situation; developing countries hosted 8.5 million refugees, or 80 percent of the global refugee population.

Global migration patterns have become increasingly complex in modern times, involving not just refugees, but also millions of economic migrants. But refugees and migrants, even if they often travel in the same way, are fundamentally different, and for that reason are treated very differently under modern international law. Migrants, especially economic migrants, choose to move in order to improve the future prospects of themselves and their families. Refugees have to move if they are to save their lives or preserve their freedom. They have no protection from their own state - indeed it is often their own government that is threatening to persecute them. If other countries do not let them in, and do not help them once they are in, then they may be condemning them to death - or to an intolerable life in the shadows, without sustenance and without rights.

Limitations and Exceptions: There are difficulties in collecting accurate statistics on refugees. Many refugees may not be aware of the need to register or may choose not to do so, and administrative records tend to overestimate the number of refugees because it is easier to register than to de-register. In addition, most industrialized countries lack a refugee register and are thus not in a position to provide accurate information on the number of refugees residing in their country. Many countries have registries that are only maintained at the local level, so the data is not centralized. The United Nations High Commissioner for Refugees (UNHCR) collects and maintains data on refugees, except for Palestinian refugees residing in areas under the mandate of the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA).

Registration is voluntary, and estimates by the UNRWA are not an accurate count of the Palestinian refugee population. The data shows estimates of refugees collected by the UNHCR, complemented by estimates of Palestinian refugees under the UNRWA mandate. Thus, the aggregates differ from those published by the UNHCR. Statistics concerning the former USSR have been reported under the Russian Federation, those concerning the former Czechoslovakia have been reported under the Czech Republic and those concerning the former Yugoslavia and 'Serbia and Montenegro' have been reported under Serbia. Since 2006, separate statistics are available for Serbia and for Montenegro. Prior to 2006, no separate statistics are available and both countries have been reported under Serbia.

Notes From Original Source: The refugee population category from 2007 onwards also includes people in a refugee-like situation, most of who were previously included in the Others of concern group. This sub-category is descriptive in nature and includes groups of persons who are outside their country or territory of origin and who face protection risks similar to those of refugees, but for whom refugee status has, for practical or other reasons, not been ascertained. Statistics concerning the former USSR have been reported under the Russian Federation, those concerning the former Czechoslovakia have been reported under the Czech Republic and those concerning the former Yugoslavia and 'Serbia and Montenegro' have been reported under Serbia. Since 2006, separate statistics are available for Serbia and for Montenegro. Prior to 2006, no separate statistics are available and both countries have been reported under Serbia.

Statistical Concept and Methodology: The United Nations High Commissioner for Refugees (UNHCR) collects and maintains data on refugees in their Statistical Online Population Database. The refugee data does not include Palestinian refugees residing in areas under the mandate of the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). However, the Palestinian refugees living outside the UNRWA areas of operation do fall under the responsibility of UNHCR and are thus included in the Statistical Online Population Database. Refugees are an important part of migrant stock. The refugee data refer to people who have crossed an international border to find sanctuary and have been granted refugee or refugee-like status or temporary protection. There are three main providers of refugee data: governmental agencies, UNHCR field offices and NGOs. Registrations, together with other sources - including estimates and surveys - are the main sources of refugee data. In

the absence of Government estimates, UNHCR has estimated the refugee population in most industrialized countries, based on recognition of asylum-seekers.

Prior to 2007, resettled refugees were included in these estimates. Up to and including 2006, to ensure that the refugee population in countries that lack a refugee registry is reflected in the global statistics, the number of refugees was estimated by UNHCR based on the arrival of refugees through resettlement programmes and the individual recognition of refugees over a 10-year (Europe and, since 2006, the United States) or 5-year (the United States before 2006, Canada and Oceania) period. Starting with the 2007 data, the cut-off period has been harmonized and now covers a 10-year period for Europe and non-European countries. Resettled refugees, however, are excluded from the refugee estimates in all countries. The 2007-2011 refugee population category includes people in a refugee-like situation, most of who were previously included in the Others of concern group.

This sub-category is descriptive in nature and includes groups of persons who are outside their country or territory of origin and who face protection risks similar to those of refugees, but for whom refugee status has, for practical or other reasons, not been ascertained. Asylum seekers - people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers - and internally displaced people - who are often confused with refugees - are not included in the data. Unlike refugees, internally displaced people remain under the protection of their own government, even if their reason for fleeing was similar to that of refugees. Palestinian refugees are people (and their descendants) whose residence was Palestine between June 1946 and May 1948 and who lost their homes and means of livelihood as a result of the 1948 Arab-Israeli conflict.

A.15 Renewable internal freshwater resources per capita (cubic meters), data for the year 2014

Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country. Renewable internal freshwater resources per capita are calculated using the World Bank's population estimates.

Source: Food and Agriculture Organization, AQUASTAT data.

Development Relevance: UNESCO estimates that in developing countries in Asia, Africa and Latin America, public water withdrawal represents just 50-100 liters (13 to 26 gallons) per person per day. In regions with insufficient water resources, this figure may be as low as 20-60 (5 to 15 gallons) liters per day. People in developed countries on average consume about 10 times more water daily than those in developing countries. While some countries have an abundant supply of fresh water, others do not have as much. UN estimates that many areas of the world are already experiencing stress on water availability. Due to the accelerated pace of population growth and an increase in the amount of water a single person uses, it is expected that this situation will continue to get worse.

The ability of developing countries to make more water available for domestic, agricultural, industrial and environmental uses will depend on better management of water resources and more cross-sectorial planning and integration. According to World Water Council, by 2020, water use is expected to increase by 40 percent, and 17 percent more water will be required for food production to meet the needs of the growing population. The three major factors causing increasing water demand over the past century are population growth, industrial development and the expansion of irrigated agriculture. Water productivity is an indication only of the efficiency by which each country uses its water resources. Given the different economic structure of each country, these indicators should be used carefully, taking into account a country's sectorial activities and natural resource endowments. According to Commission on Sustainable Development (CSD) agriculture accounts for more than 70 percent of freshwater drawn from lakes, rivers and underground sources. Most is used for irrigation which provides about 40 percent of the world food production.

Poor management has resulted in the salinization of about 20 percent of the world's irrigated land, with an additional 1.5 million ha affected annually. There is now ample evidence that increased hydrologic variability and change in climate has and will continue to have a profound impact on the water sector through the hydrologic cycle, water availability, water demand, and water allocation at the global, regional, basin, and local levels. Properly managed water resources are a critical component of growth, poverty reduction and equity. The livelihoods of the poorest are critically associated with access to water services. A shortage of water in the future would be detrimental to the human population as it would affect everything from sanitation, to overall health and the production of grain. Freshwater use by continents is partly based on several socio-economic development factors, including population, physiography, and climatic characteristics.

It is estimated that in the coming decades the most intensive growth of water withdrawal is expected to occur in Africa and South America (increasing by 1.5-1.6 times), while the smallest growth will take place in Europe and North America (1.2 times). The Commission for Sustainable Development (CSD) has reported that many countries

lack adequate legislation and policies for efficient and equitable allocation and use of water resources. Progress is, however, being made with the review of national legislation and enactment of new laws and regulations.

Limitations and Exceptions: A common perception is that most of the available freshwater resources are visible (on the surfaces of lakes, reservoirs and rivers). However, this visible water represents only a tiny fraction of global freshwater resources, as most of it is stored in aquifers, with the largest stocks stored in solid form in the Antarctic and in Greenland's ice cap. The data on freshwater resources are based on estimates of runoff into rivers and recharge of groundwater. These estimates are based on different sources and refer to different years, so cross-country comparisons should be made with caution. Because the data are collected intermittently, they may hide significant variations in total renewable water resources from year to year. The data also fail to distinguish between seasonal and geographic variations in water availability within countries. Data for small countries and countries in arid and semiarid zones are less reliable than those for larger countries and countries with greater rainfall.

Caution should also be used in comparing data on annual freshwater withdrawals, which are subject to variations in collection and estimation methods. In addition, inflows and outflows are estimated at different times and at different levels of quality and precision, requiring caution in interpreting the data, particularly for water-short countries, notably in the Middle East and North Africa. The data are based on surveys and estimates provided by governments to the Joint Monitoring Programme of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). The coverage rates are based on information from service users on actual household use rather than on information from service providers, which may include nonfunctioning systems.

Statistical Concept and Methodology: Renewable water resources (internal and external) include average annual flow of rivers and recharge of aquifers generated from endogenous precipitation, and those water resources that are not generated in the country, such as inflows from upstream countries (groundwater and surface water), and part of the water of border lakes and/or rivers. Non-renewable water includes groundwater bodies (deep aquifers) that have a negligible rate of recharge on the human time-scale. While renewable water resources are expressed in flows, non-renewable water resources have to be expressed in quantity (stock). Runoff from glaciers where the mass balance is negative is considered non-renewable. Renewable internal freshwater resources per capita are calculated using the World Bank's population estimates. The unit of calculation is m3/year per inhabitant. Internal renewable freshwater resources per capita are calculated using the World Bank's population estimates.

Total actual renewable water resources correspond to the maximum theoretical yearly amount of water actually available for a country at a given moment. The unit of calculation is km3/year or 109 m3/year. Calculation Criteria is [Water resources: total renewable (actual)] = [Surface water: total renewable (actual)] + [Groundwater: total renewable (actual)] - [Overlap between surface water and groundwater].* Fresh water is naturally occurring water on the Earth's surface. It is a renewable but limited natural resource. Fresh water can only be renewed through the process of the water cycle, where water from seas, lakes, forests, land, rivers, and dams evaporates, forms clouds, and returns as precipitation. However, if more fresh water is consumed through human activities than is restored by nature, the result is that the quantity of fresh water available in lakes, rivers, dams and underground waters can be reduced which can cause serious damage to the surrounding environment.

A.16 Total natural resources rents (% of GDP), data for the year 2015

Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.

Source: Estimates based on sources and methods described in "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (World Bank, 2011).

Development Relevance: Accounting for the contribution of natural resources to economic output is important in building an analytical framework for sustainable development. In some countries earnings from natural resources, especially from fossil fuels and minerals, account for a sizable share of GDP, and much of these earnings come in the form of economic rents - revenues above the cost of extracting the resources. Natural resources give rise to economic rents because they are not produced. For produced goods and services competitive forces expand supply until economic profits are driven to zero, but natural resources in fixed supply often command returns well in excess of their cost of production. Rents from nonrenewable resources - fossil fuels and minerals - as well as rents from overharvesting of forests indicate the liquidation of a country's capital stock. When countries use such rents to support current consumption rather than to invest in new capital to replace what is being used up, they are, in effect, borrowing against their future.

Limitations and Exceptions: This definition of economic rent differs from that used in the System of National Accounts, where rents are a form of property income, consisting of payments to landowners by a tenant for the use of the land or payments to the owners of subsoil assets by institutional units permitting them to extract subsoil deposits.
Periodicity: Annual

Statistical Concept and Methodology: The estimates of natural resources rents are calculated as the difference between the price of a commodity and the average cost of producing it. This is done by estimating the world price of units of specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs (including a normal return on capital). These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP).

A.17 Unemployment, total (% of total labor force) (national estimate), data for the year 2016

Unemployment refers to the share of the labor force that is without work but available for and seeking employment. Definitions of labor force and unemployment differ by country.

Source: International Labour Organization, Key Indicators of the Labour Market database.

Development Relevance: Paradoxically, low unemployment rates can disguise substantial poverty in a country, while high unemployment rates can occur in countries with a high level of economic development and low rates of poverty. In countries without unemployment or welfare benefits people eke out a living in vulnerable employment. In countries with well-developed safety nets workers can afford to wait for suitable or desirable jobs. But high and sustained unemployment indicates serious inefficiencies in resource allocation. Youth unemployment is an important policy issue for many economies.

Young men and women today face increasing uncertainty in their hopes of undergoing a satisfactory transition in the labour market, and this uncertainty and disillusionment can, in turn, have damaging effects on individuals, communities, economies and society at large. Unemployed or underemployed youth are less able to contribute effectively to national development and have fewer opportunities to exercise their rights as citizens. They have less to spend as consumers, less to invest as savers and often have no "voice" to bring about change in their lives and communities. Widespread youth unemployment and underemployment also prevents companies and countries from innovating and developing competitive advantages based on human capital investment, thus undermining future prospects. Unemployment is a key measure to monitor whether a country is on track to achieve the Sustainable Development Goal of promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. [SDG Indicator 8.5.2]
General Comments: The series for ILO estimates is also available in the WDI database. Caution should be used when comparing ILO estimates with national estimates.

Limitations and Exceptions: The criteria for people considered to be seeking work, and the treatment of people temporarily laid off or seeking work for the first time, vary across countries. In many cases it is especially difficult to measure employment and unemployment in agriculture. The timing of a survey can maximize the effects of seasonal unemployment in agriculture. And informal sector employment is difficult to quantify where informal activities are not tracked. There may be also persons not currently in the labour market who want to work but do not actively "seek" work because they view job opportunities as limited, or because they have restricted labour mobility, or face discrimination, or structural, social or cultural barriers.

The exclusion of people who want to work but are not seeking work (often called the "hidden unemployed" or "discouraged workers") is a criterion that will affect the unemployment count of both women and men. However, women tend to be excluded from the count for various reasons. Women suffer more from discrimination and from structural, social, and cultural barriers that impede them from seeking work. Also, women are often responsible for the care of children and the elderly and for household affairs. They may not be available for work during the short reference period, as they need to make arrangements before starting work. Further, women are considered to be employed when they are working part-time or in temporary jobs, despite the instability of these jobs or their active search for more secure employment.

Long Definition: Unemployment refers to the share of the labor force that is without work but available for and seeking employment. Definitions of labor force and unemployment differ by country.

Statistical Concept and Methodology: The standard definition of unemployed persons is those individuals without work, seeking work in a recent past period, and currently available for work, including people who have lost their jobs or who have voluntarily left work. Persons who did not look for work but have an arrangements for a future job are also counted as unemployed. Some unemployment is unavoidable. At any time some workers are temporarily unemployed between jobs as employers look for the right workers and workers search for better jobs. It is the labour force or the economically active portion of the population that serves as the base for this indicator, not the total population.

Appendix B Software script in S-PLUS (R)

Here, we give the S-PLUS script used to read and couple human security indicators from various institutes. Indicators relevant to the present study, are combined into dataframe 'Tension'. From the script below other subsets can be arranged easily. In all cases, rows are for 191 countries, consistent with the INFORM database of JRC. All data in the dataframe Tension are selected for the year 2016 (or as close as possible to this year).

```
#########################################################################
#
# Building the database for the Planetary Security Initiative.
#
# Basis is formed by the INFORM-database of JRC where indicators
# are given for 191 landen.
# Important indicators are combined in dataframe 'Tension'.
#
# Date last verions: July 26, 2018
#
# Sources:
#
# 1)  INFORM2016 of JRC. See this report Section 2.2.10.
# 2)  EM-DAT of CRED 1980-2015. See this report Section 2.2.1.
# 3)  Education index from Human Development report 2016. See this report Section 2.2.5.
# 4)  Battle field deaths from UDCP 2015/2016. See this report Section 2.2.7.
# 5)  Global Peace Index 2016. See this report Section 2.2.6.
# 6)  Fragile States indices 2016. See this report Section 3.2.3.
# 7)  GCRI of JRC 2016. See this report Section 2.2.10.
# 8)  World Bank data plus governance 2015/2016. See this report Sections 2.2.3 and 2.2.4.
# 9)  World Risk Index (WRI), BEH Stuttgart 2016. See this report Section 3.2.4.
# 10) Data Univ. of Notre Dame 2016
# 11) GermanWatch and Munich Re, upto 2015. See this report Section 3.2.4.
# 12) UN-OCHA CIRV, 2016. See this report Section 3.2.2.
# 13) GAR life years, data up to 2012. See this report Section 3.2.4.
# 14) Happiness indicator 2017. See this report Section 2.2.8.
# 15) Aridity index.
# 16) Migration data. See this report Section 2.2.9.
# 17) Age distributions (youth bulges) 2016. See this report Section 2.2.5.
# 18) Homocide data from UN-ODC 2010-2015. See this report Section 2.2.7.
#
#########################################################################
#
# 1) INFORM database of JRC, last version 2017 used here is version 32.
# NB: version 31 had a number of errors! Missing data were set to 0 or 10 ..
#
names(INFORMbasisdata)
#
# INFORMbasisdata <- INFORMbasisdata[c(1:40,42:81,41,82:191),]
#
INFORM2017 <- INFORM.Mid2017.v032
names(INFORM2017)

INFORM2017 <- cbind(INFORM2017,INFORM[,c(35,36,37,39)])
#
# Code is the variable which gives a global spit to OECD (=1), BRIICS (=2) and Other (=3)
#
INFORM2017$Pop2015mil <- INFORMbasisdata[,55]/1000000
INFORM2017$GDPc2016th <- INFORMbasisdata[,54]/1000
#
#
# frame Hazard containts Hazard and Exposure indicators
#
names(Hazard)
#
# frame Vulnerability contains vulnerability indicators.
#
names(Vulnerability)
Vulnerability <- Vulnerabililty
Tension$Malaria <- Vulnerability$Malaria.mortality.rate
Tension$UprootedAbs <- Vulnerability[,16]
```

```
Tension$UprootedRel <- Vulnerability[,18]

Tension$Food.Security <- Vulnerability[,35]
Tension$Health.Conditions <- Vulnerability[,23]
Tension$Children.Under.5 <- Vulnerability[,26]
Tension$Inequality <- Vulnerability[,8]
Tension$GDPcLog <- log(Tension$GDPc)
#
# and now indicators for CopingCapacity
#
names(CopingCapacity)
Tension$Corruption <- CopingCapacity$Corruption.Perception.Index
Tension$EffectiveGov <- CopingCapacity$Government.Effectiveness
Tension$GovernanceInform <- CopingCapacity$Goverance
#
# In conclusions: INFORM2017, Hazard, Vulnerability en CopingCapacity
# Original INFORM data in: INFORMbasisdata
#
Tension <- INFORM2017[,c(1,2,8,11,24,32,33)]
names(Tension) <- c("Country","ISO3","INFORMnatdis","INFORMconflicts","INFORMvulnerability",
  "INFORMcopcapacity","INFORMrisk")

Tension$HDI <- INFORMbasisdata$Human.Development.Index
Tension$MPI <- INFORMbasisdata$Multidimensional.Poverty.Index
Tension$Governance <- CopingCapacity$Governance

Tension$GovernanceScaled <- CopingCapacity$Governance
Tension$GovernanceScaled <- (Tension$Governance - min(Tension$Governance,na.rm=T)) /
   (max(Tension$Governance,na.rm=T) - min(Tension$Governance,na.rm=T))

min(Tension$GovernanceScaled,na.rm=T)
max(Tension$GovernanceScaled,na.rm=T)

Tension$GovernanceScaled <- (1.0 - Tension$GovernanceScaled) * 10
names(Tension)

Tension$GDPc <- INFORM2017$GDPc2015th
Tension <- cbind(Tension,INFORM2017[,c(36,38,39,41)])
#
#############################################################################
#
# 2) Now EM-DAT database of CRED.
# Couple data from CRED-database. The frame is 'DisastersCFrecode'.
# Country names are defined identical to INFORM (191 countries)
# Country averages 1996-2015 are coupled to INFORM.
# Next to that a category selection has been made for water-related
# disasters.
# Older computations were made in script CRED2015. Here, the
# frame DisastersCF is made for data tot up to and including 2015.
#
#########################################################################
#
# Selection of water-related data over the years 1996-2015.
# This to compare these data to indicators within INFORM.
#
# This has been arranged in the script: CREDhercoderingLanden2016
# Here, disaster data for "water-related" and all 8 types disasters has been calculated.
#
names(DisastersPerLandWater2)

Tension$Killed.w.disasters <- DisastersPerLandWater2$KilledWater.norm
Tension$Affected.w.disasters <- DisastersPerLandWater2$AffWater.norm
Tension$Damage.w.disasters <- DisastersPerLandWater2$DamWater.norm
#
#############################################################################
#
# 3) Now we add the Education Index van Human Development Index toevoegen.
#
#########################################################################
#
# Extracted from the dataset Human Development Index
#
EI2
EducIndex <- EI2[c(1:40,45,41:44,46:191),1:2]
test <- data.frame(cbind(EducIndex,INFORM2017[,1:2]))
```

```
EducIndex$EInorm <- 10 * EducIndex[,2]
#
# now integration with INFORM.
#
EducIndexFin <- merge(EducIndex,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
names(EducIndexFin)
Tension$Education <- EducIndexFin$EInorm
#
#############################################################################
#
# 4) Country averages for Conflicts, to be coupled to INFORM.
# Battle field deaths, normalized from minimum 0 to maximum 10.
# The frame 'ConflictsRecode' contains country names consistent with
# those of INFORM.!
#
# Re-coding of country names is given in script 'HercoderingLandenBattleField'
#
#############################################################################
#
names(ConflictsRecode)
#
# NB: we also can select here on $code 1,2 en 3: interstate,
# intrastate and one-sided violence.
#
Sel <- ConflictsRecode
ConflictsPerLand <- aggregate.data.frame(Sel[,3:5],by=Sel$Country,sum,na.rm=T)
ConflictsPerLand
#
Sel <- ConflictsRecode[ConflictsRecode$Year > 2004,]
ConflictsPerLand2005 <- aggregate.data.frame(Sel[,3:5],by=Sel$Country,sum,na.rm=T)
ConflictsPerLand2005

names(ConflictsPerLand2005)
ConflictsPerLand2 <- merge(ConflictsPerLand2005,INFORM2017[,1:2],by.x="Sel.Country",by.y="COUNTRY",all.y=T)
ConflictsPerLand2[is.na(ConflictsPerLand2)] <- 0.0
#
# data for a 5 year period: Conflicts5yPerLand
#
Conflicts5yPerLand <- merge(Conflicts5yPerLand,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
Conflicts5yPerLand[is.na(Conflicts5yPerLand)] <- 0.0
#
# Add homicides
#
ViolenceIndicator <- cbind(Conflicts5yPerLand[,1:2],Homicide[,2])
names(Tension)
ViolenceIndicator <- cbind(ViolenceIndicator,Tension[,c(8,18,21)])
ViolenceIndicator$ConflictDeathsC <- 0.1*ViolenceIndicator$KilledBest/ViolenceIndicator$Pop
ViolenceIndicator$HomicideC <- 0.1*ViolenceIndicator$Homicide/ViolenceIndicator$Pop

length(ViolenceIndicator$ConflictDeathsC[ViolenceIndicator$ConflictDeathsC < 0.1])
ViolenceIndicator2 <- ViolenceIndicator[ViolenceIndicator$ConflictDeathsC > 0.1,]

ViolenceIndicator$ViolenceTot <- ViolenceIndicator$ConflictDeathsC + ViolenceIndicator$HomicideC
ViolenceIndicator$ViolenceTotLog <- log(ViolenceIndicator$ViolenceTot + 1.0)
ViolenceIndicator$ViolenceTotScaled <- 10*(ViolenceIndicator$ViolenceTotLog -
     min(ViolenceIndicator$ViolenceTotLog,na.rm=T))/max(ViolenceIndicator$ViolenceTotLog,na.rm=T)

ViolenceIndicator$ViolenceTot2 <- 10*ViolenceIndicator$ConflictDeathsC + ViolenceIndicator$HomicideC
ViolenceIndicator$ViolenceTot2Log <- log(ViolenceIndicator$ViolenceTot2 + 1.0)
ViolenceIndicator$ViolenceTot2Scaled <- 10*(ViolenceIndicator$ViolenceTot2Log -
         min(ViolenceIndicator$ViolenceTot2Log,na.rm=T))/max(ViolenceIndicator$ViolenceTot2Log,na.rm=T)
#
Tension$Violence <- ViolenceIndicator$ViolenceTotScaled
Tension$Violence2 <- ViolenceIndicator$ViolenceTot2Scaled
#
names(Tension)

names(ConflictsPerLand2)
Tension$BattleAbs <- ConflictsPerLand2$KilledBest
Tension$BattleNorm <- ConflictsPerLand2$Battle2005.norm
Tension$BattleBoolean <- ConflictsPerLand2$BattleBoolean
Tension$BattleAbsLog <- log(Tension$BattleAbs + 1)
names(Tension)
#
# This frame contains battle field deaths for codes 1, 2 en 3,
# summed over 10 years: 2005 tot en met 2014.
```

```
#
# Normalize for size of population.
#
ConflictsPerLand2$Battle2005.norm <-
              log((ConflictsPerLand2$KilledBest / INFORM2017$Pop2015mil) +1)
ConflictsPerLand2$Battle2005.norm <-
           10*ConflictsPerLand2$Battle2005.norm / max(ConflictsPerLand2$Battle2005.norm)
#
sum(ConflictsPerLand2$Battle2005.norm >= 0.1)
sum(Tension$BattleAbsLog >= 4.0)
exp(4)-1
#
# Thus, if more than 54 deaths orif log(battle field deaths + 1) >= 4.
# This almost equals the choice for  normalized battlefield deathes > 0.1.
#
ConflictsPerLand2$BattleBoolean <- rep(0.0,191)
ConflictsPerLand2$BattleBoolean[ConflictsPerLand2$Battle2005.norm >= 0.1] <- 1.0
#
# NB: here by hand USA, GB en China setted to 0.0 because countries involved in proxy wars,
# and not in their own territory.
#
##############################################################################
#
# 5) Global Peace Index of IEP 2016
# GPI is normalized to minimum 0 and maximum 10 (consistent with INFORM procedure).
#
names(GPI2016)
GPI2016Fin <- merge(GPI2016,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
names(GPI2016Fin)
#
Tension$GPI2016 <- GPI2016Fin[,2]
names(Tension)

min(Tension$GPI2016,na.rm=T)
max(Tension$GPI2016,na.rm=T)

Tension$GPI2016scaled <- (Tension$ConflictsGPI - min(Tension$ConflictsGPI,na.rm=T)) /
   (max(Tension$ConflictsGPI,na.rm=T) - min(Tension$ConflictsGPI,na.rm=T))

min(Tension$GPI2016scaled,na.rm=T)
max(Tension$GPI2016scaled,na.rm=T)

Tension$GPI2016scaled <- (1.0 - Tension$GPI2016scaled) * 10
#
GPI2016Fin$GPIscore.norm <- 3.5*(GPI2016Fin$GPI.Overall.Score - 1)

min(GPI2016Fin$GPIscore.norm,na.rm=T)
max(GPI2016Fin$GPIscore.norm,na.rm=T)
#
##############################################################################
#
# 6) Fragile states.
#
##############################################################################
#
FragileStates <- merge(Fragile.states.Splus,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
names(FragileStates)
#
Tension$FragStates <- FragileStates[,2]
Tension$Group.grievances <- FragileStates[,5]
Tension$Human.rights <- FragileStates[,11]
Tension$Factionalized.elites <- FragileStates[,13]
#
##############################################################################
#
# 7) JRC database GCRI: 22 variables.
#
test <- merge(GCRI2014,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
test2 <- merge(test,INFORM2017[,1:2],by.x="COUNTRY.y",by.y="COUNTRY",all.y=T)
names(test2)
#
# met de hand 2 kolommen verwijderd!
#
names(test2) <- c("Country","ISO3","Pol1.RegimeType","Pol2.LackDemocracy","Pol3.GovEffectiv",
 "Pol4.EmpowerRights","Pol5.LevelRepression","Sec1.Conflict.NB","Sec2.YRS.HVC","Sec3.ConflictTrend",
 "Sec4.RecIntConfl","Soc1.InfantMortality","Soc2.SocialDispersion","Soc3.Homicide","Soc4.EthnicSN",
```

```
 "Soc5.EthnicNP","Econ1.GDPc","Econ2.ECON.ISO","Econ3.IncomeInequal","Econ4.FoodAccess",
 "GeoEnv1.Population","GeoEnv2.WaterStress","GeoEnv3.OilProducer","GeoEnv4.StrucConstr")
GCRI <- test2
#

#####################################################################
#
# 8) World Bank data
#
#############################################################################
#
names(World.Bank.Indicators)
Bank <- merge(World.Bank.Indicators,INFORM2017[,1:2],by.x="Country.Code",by.y="ISO3",all.y=T)
Bank2 <- merge(Bank,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(Bank2)
Tension$Youth14  <- Bank2$PopUnder14.2015
Tension$StatCap2016 <- Bank2$StatCap2016
Tension <- cbind(Tension, Bank2[,c(6,7,10,43,46)])
Tension <- cbind(Tension, Bank2[,77:80])
DRIVERS <- cbind(DRIVERS, Bank2[,77:80])
Tension <- cbind(Tension, Bank2[,81:83])
DRIVERS <- cbind(DRIVERS, Bank2[,81:83])
Tension$PopGrowth2015  <- Bank2$PopGr2015
Tension$PopGrowth2016  <- Bank2$PopGrowth2016
Tension$OresMetalsExport  <- Bank2$OresMet2016
Tension$OresMetalsExportLog  <- log(Bank2$OresMet2016)
Tension$Renewable.water.c.log  <- log(Tension$Renewable.water.c)
Tension$Agri.as.perc.GDP.log  <- log(Tension$Agri.as.perc.GDP)

Tension$Agri.perc.GDP  <- Bank2$Agri.perc.GDP2016
Tension$Agri.perc.GDP.log  <- log(Bank2$Agri.perc.GDP2016)
Tension$IntMigrstock2015.log  <- log(Tension$IntMigrstock2015)

Tension$RefugeesAsy2016 <- Bank2$RefugeesAsy2016
Tension$RefugeesOri2016 <- Bank2$RefugeesOri2016
Tension$Refugees.Origin <- 10 * log(Bank2$RefugeesOri2016) / max(log(Bank2$RefugeesOri2016),na.rm=T)
Tension$Unemployment  <- Bank2$Unemployment2016


x <- Tension$RefugeesOri2016/Tension$Pop
xx <- log(x)
xx
xxx <- xx - min(xx)
xxxx <- 10 * xxx / max(xxx)
xxxx
Tension$Refugees.Origin.rel <- xxxx

y <- (Tension$RefugeesOri2016 + Tension$IDPs)/Tension$Pop
yy <- log(y)
yy
yyy <- yy - min(yy,na.rm=T)
yyyy <- 10 * yyy / max(yyy,na.rm=T)
yyyy
Tension$Uprooted.people.2016 <- yyyy

z <- Tension$Population.size
zz <- log(z)
zz
zzz <- zz - min(zz)
zzzz <- 10 * zzz / max(zzz)
zzzz
Tension$Population.log <- zzzz


Tension$Countr <- Tension$Country
Tension$IDPs <- Tension$IDPsConflict2016
#
#####################################################
#
# Data taken from WorldBankGoverance Excel spreadsheet Splus
# Six indicators for Governance: Voice and accountability, political stability,
# Government effectiveness, Regulatory quality, Rule of Law and Control of corruption.
#
```

```
################################################
#
Governance2016

GovernanceWB <- cbind(Governance2016,Governance.2[,3:6])
GovernanceWB <- cbind(GovernanceWB,Governance.3[,3:6])
GovernanceWB <- cbind(GovernanceWB,Governance.4[,3:6])
GovernanceWB <- cbind(GovernanceWB,Governance.5[,3:6])
GovernanceWB <- cbind(GovernanceWB,Governance.6[,3:6])

Gov1 <- merge(GovernanceWB,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
Gov2 <- merge(Gov1,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(Gov2)
#
# test how World Bank 'control of corruption' relates to Corruption
# uit INFORM2017. Heel mooi!
#
Gov3 <- cbind(Gov2,CopingCapacity[,5:7])
names(Gov3)

Tension$CorruptionWB <- Gov3$CC2016
Tension$EffectiveGovWB <- Gov3$GE2016
#
#############################################################################################
#
# 9) Reading from WorldRiskIndex 2016 (BEH Stuttgart)
#
#############################################################################
#
names(WorldRiskIndex2016)
WorldRiskIndex2016Fin <- merge(WorldRiskIndex2016,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)

Tension$WRI2016 <- WorldRiskIndex2016Fin[,2]
Tension$WRIvuln <- WorldRiskIndex2016Fin[,4]
#
#############################################################################
#
# 10) Data Paris Notre Dame University: Readiness and Vulnerability
#
#############################################################################
#
names(ReadinessParis)
names(VulnerabilityParis)

ReadyP <- merge(ReadinessParis,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
ReadyP2 <- merge(ReadyP,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(ReadyP2)

VulnP <- merge(VulnerabilityParis,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
VulnP2 <- merge(VulnP,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(VulnP2)

Tension$ReadinessParis <- ReadyP2$Readiness
Tension$VulnerabilityParis <- VulnP2$Vulnerability2015
#
#############################################################################
#
# 11) GermanWatch published disaster data per country coming from Munich Re 1996-2015,
#     thus 20-year averages. Also data for 2015 alone!
#
#############################################################################
#
names(MunichRe20years) <- c("CRIrank","Country","CRIscore",
   "Fatalities","FatalitiesRel","Losses","LossesRel")

names(MunichRe2015) <- c("CRIrank","Country","CRIscore",
   "Fatalities","FatalitiesRel","Losses","LossesRel")


MunichRe20 <- merge(MunichRe20years,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)

MunichRe2015R <- merge(MunichRe2015,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)


Tension$CRIscore <- MunichRe20$CRIscore
#
```

```
#########################################################################
#
# 12) UN-OCHA uses 50% INFORM and adds other indicators.
#     These data are for mid 2016. See report. Name: CIRV
#
#########################################################################
#
names(CIRV2016)

CIRV <- merge(CIRV2016,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)

Tension$CIRV <- CIRV$CIRV
#
#########################################################################
#
# 13) GAR lifeyears for disasters 1980-2012
#
# Name: Lifeyears
#
#########################################################################
#
names(Lifeyears)
help(aggregate)

LifeyearAbs <- data.frame(matrix(nrow=220,ncol=34))
LifeyearRel <- data.frame(matrix(nrow=220,ncol=34))

LifeyearAbs[,1:2] <- Lifeyears[1:220,2:3]
LifeyearRel[,1:2] <- Lifeyears[1:220,c(2,4)]

for (i in 2:33){
  LifeyearAbs[,1 + i] <- Lifeyears[(i-1)*220 + 1:220,3]
  LifeyearRel[,1 + i] <- Lifeyears[(i-1)*220 + 1:220,4]
}

Lifes <- data.frame(LifeyearAbs[,1])
#
# nu correctie op landennamen
#
Lifes$Abs <- rowMeans(LifeyearAbs[,2:34])
Lifes$Rel <- rowMeans(LifeyearRel[,2:34])
Lifes
#
#########################################################################
#
# 14) Happiness indicator 2017
#
# Name: Happpiness
#
#########################################################################
#
names(Happiness)

Happy <- merge(Happiness,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)

Tension$Happiness <- Happy$Happiness
names(Tension)
Tension$Unemployment <- Bank2$Unempl2014

#########################################################################
#
# 15) Aridity 2010, as taken from IMAGE software
#
# Name: Aridity2010
#
#########################################################################
#
names(Aridity2010)
Aridity <- Aridity2010
Aridity[is.na(Aridity2010)] <- 0.0
Aridity$PercDryland <- 100 *(Aridity[,3]+Aridity[,4]+Aridity[,5]+Aridity[,6]) /
    (Aridity[,3]+Aridity[,4]+Aridity[,5]+ Aridity[,6] + Aridity[,7])

Arid <- merge(Aridity,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
Arid2 <- merge(Arid,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(Arid2)
```

```
Tension$Arid <- Arid2[,9]

#########################################################################
#
# 16) Data on migration: IDPs and refugees
#     Important sources UNHCR, IDMC and INFORM.
#
#########################################################################
#
Migration <- Vulnerability[,c(1,2,15:19)]
names(Migration)
names(Migration) <- c("COUNTRY","ISO3","UprootedThAbs","UprootedAbsScaled",
              "UprootedPerc","UprootedPercScaled","UprootedINFORM")
names(IDPs2016)

IDPs <- merge(IDPs2016,INFORM2017[,1:2],by.x="ISO3",by.y="ISO3",all.y=T)
IDP2 <- merge(IDPs,INFORM2017[,1:2],by.x="COUNTRY",by.y="COUNTRY",all.y=T)
names(IDP2)

Migration <- cbind(Migration,IDP2[,3:5])
names(Migration)
names(Bank2)
names(Tension)
Migration <- cbind(Migration,Bank2[,c(49,52,81,82)])
#
# frame to see wich variables are of importance for tensions, violence and conflict.
#
TensionVars <- cbind(GPI2016Fin[,c(1,2,5,6,15,22,25)],Migration)
TensionVars <- cbind(TensionVars,Tension[,c(18,31,32)])
names(TensionVars)

Tension <- cbind(Tension,Migration[,3:10])
names(Tension)
#
#############################################################################
#
# 17) Age distributions taken from UN Population Prospects.
#
help(rowSums)
names(UN.prospects2100)
UN.prospects2100$PopTot <- rowSums(UN.prospects2100[,4:24])
UN.prospects2100$Youth <- rowSums(UN.prospects2100[,7:9])
UN.prospects2100$YouthRel <- 100 * UN.prospects2100$Youth/ UN.prospects2100$PopTot
UN.prospects2100$Youth14 <- rowSums(UN.prospects2100[,4:6])
UN.prospects2100$Youth14Rel <- 100 * UN.prospects2100$Youth14 / UN.prospects2100$PopTot

UN.prospects2100$Youth1524 <- rowSums(UN.prospects2100[,7:8])
UN.prospects2100$Youth15plus <- rowSums(UN.prospects2100[,7:24])
UN.prospects2100$Youth15Rel <- 100 * UN.prospects2100$Youth1524 / UN.prospects2100$Youth15plus

UN2015 <- UN.prospects2100[UN.prospects2100$Year == 2015,c(1,25:32)]
UN2050 <- UN.prospects2100[UN.prospects2100$Year == 2050,c(1,25:32)]
names(UN2015) <- c("Country","YouthBulge2015","YouthBulgePerc2015","Population2015","Youth142015",
  "Youth14Perc2015","Youth15242015","Youth15plus2015","YouthUrdalPerc2015")
names(UN2050) <- c("Country","YouthBulge2050","YouthBulgePerc2050","Population2050","Youth142050",
      "Youth14Perc2050","Youth15242050","Youth15plus2050","YouthUrdalPerc2050")

UN <- cbind(UN2015,UN2050[,2:9])

UNtest <- merge(UN,INFORM2017[,1:3],by.x="Country",by.y="COUNTRY",all=T)
#
# UN getransformeerd naar data.frame: nu UN.df via data en transform.
# Nu read only weg!!
#
UNyouth <- merge(UN.df,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
# UNyouth2 <- cbind(UNyouth,Tension$Pop,Tension$Youth14)
names(UNyouth)
#
# check for data from earlier data: perfect!
# Now, the frame is UNyouth, it has been checked for consistency!
#
names(UNyouth)
UNyouthbulge

Tension$YouthBulgePerc2015 <- UNyouth$YouthBulgePerc2015
```

```
Tension$YouthUrdalPerc2015 <- UNyouth$YouthUrdalPerc2015
Tension$Youth14Perc2015 <- UNyouth$Youth14Perc2015
#
################################################################################################
#
# 18 Add Homicide 2010-2015 from UN-ODC
#
################################################################################################
#
names(Homicide2015)
#
# Venezuela: 18000 and GB: 600
#
Homicide <- merge(Homicide2015,INFORM2017[,1:2],by.x="Country",by.y="COUNTRY",all.y=T)
#
################################################################################################
#
# extra test for the number of surrounding countries, area per country, abs number of people
#
names(INFORM2017)
Tension$Omringend <- Lnum[,2]
Tension$Pop <- INFORM2017$Pop2015mil
Tension$Area <- INFORM2017$AreaKm2
#
#########################################################################
#
# now summary for all 14 frames
#
names(INFORM2017)
names(INFORMbasisdata)
names(Hazard)
names(Vulnerability)
names(CopingCapacity)
names(DisastersPerLand)
names(EducIndexFin)
names(FragileStates)
names(GCRI)
names(Bank2)
names(WorldRiskIndex2016)
names(ReadyP2)
names(VulnP2)
names(Tension)
#
#####################################################################
```