Integrating environment into humanitarian risk – Development and use of an environmental emergency risk index to inform capacity development interventions

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Abstract
This master thesis is an attempt to investigate to what extent the Environmental Emergency Risk Index (EER Index), which was recently developed by the Joint UNEP/OCHA Environment Unit (JEU), fit field staff and expert perceptions of environmental emergency risk. The findings reveal that the EER Index does not coincide very well with the views of the experts and field staff and that there are some methodological aspects of the development of the index that need to be further refined. Suggestions for improvement of the EER Index conclude that initially more research is needed regarding the choice of indicators, both from researchers and practitioners, and also regarding the analytical and mathematical methodology with respect to uncertainty and sensitivity analysis, to increase the legitimacy and credibility of the index.

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PREFACE BY THE AUTHORS

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Heidi & Josefin

ABBREVATIONS

CADRI	Capacity for Disaster Risk Initiative
DHA	Department of Humanitarian Affairs
EER Index	Environmental Emergency Risk Index
EPI	Environmental Performance Index
GDP	Gross Domestic Product
GFM	Global Focus Model
HDI	Human Development Index
HFA	Hyogo Framework for Action
InfoRM	Index for Risk Management
JEU	Joint UNEP/OCHA Environment Unit
LDI	Land Degradation Impact
MAR	Missing At Random
MCAR	Missing Completely At Random
MDG	Millennium Development Goals
NMAR	Not Missing At Random
NSO	National Statistics Office
OCHA	Office for the Coordination of Human Affairs
OCHA ROAP	OCHA Regional Office for Asia and the Pacific
OCHA ROCCA	OCHA Regional Office for the Caucasus and Central Asia
OCHA ROSA	OCHA Regional Office for Southern Africa
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNDP RBEC	UNDP Regional Bureau for Europe and the Commonwealth of Independent States
UNEP	United Nations Environment Programme
UNEP ROE	UNEP Regional Office for Europe

DEFINITIONS

Due to the many different interpretations of common risk related concepts, stemming from the fact that there are no common nor established definitions in use today (Birkmann J. , 2007, p. 20), the following definitions will be used in this report.

ENVIRONMENTAL EMERGENCY

United Nations Environment Programme (UNEP) defines an environmental emergency as "*a sudden onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that cause or threaten to cause severe environmental damage as well as harm to human health and/or livelihoods.*" (UNEP, 2003).

ENVIRONMENTAL INDICATOR

An indicator is a measurement of a system and its state (Jakobsen, Stuart, & Draggan, 2008; Smeets & Weterings, 1999, p. 4). An environmental indicator is thus developed and validated to reflect and monitor the trends in the state of the environment (ibid.).

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The definitions regarding which concept, index, composite indicators or composite index, to use when describing the mathematical combination of indicators differ in literature (de Groeve, Poljansek, & Vernaccini, 2014; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008; Giannetti, Bonilla, Silva, & Almeida, 2009). To increase the understanding of this study, the term index will be used when talking about this concept.

ENVIRONMENTAL INDICES

By using environmental indices the complex reality is measured, simplified and communicated (Barnett, Lambert, & Fry, 2008, p. 103). This is beneficial since it gives decision makers access to organised environmental data that is comprehensible and useful in their line of work (Barnett, Lambert, & Fry, 2008, p. 103; Pelling, 2004, p. 9). The simple purpose of environmental indices is to facilitate the comparison of states of the environment across time and space (Ebert & Welsch, 2004, p. 270). With the inclusion of time series data, the constituent entities can also see how their own performance has changed over time (Hsu, et al., 2014, p. 1). The simple strive of such indices is that they be free of ambiguity and provide clear and transparent comparisons (Ebert & Welsch, 2004, p. 271).

The definition used in this thesis is derived from de Sherbinin, Reuben, Levy & Johnson (2013) where an environmental index is an aggregate of environmental indicators, which generally implies conversion to common units and application of weights.

EXECUTIVE SUMMARY

As climate change coupled with other trends such as fast developing industries, unregulated urbanisation as well as poor urban planning threaten to increase the frequency and intensity of disasters worldwide, there is much incentive to increase preparedness and capacities to cope with these kinds of events.

This master thesis is an attempt to investigate to what extent the Environmental Emergency Risk Index (EER Index), which was recently developed by the Joint UNEP/OCHA Environment Unit (JEU), fit field staff and expert perceptions of environmental emergency risk. The investigation mainly targets the choice of indicators as well as the methods of weighting, normalisation and aggregation by providing input from interviews and literature studied. The long term perspective is to use the EER Index to enhance national preparedness for effective response to environmental emergencies, both regarding the resource efficiency of the JEU and the overall national efficiencies.

The investigation process regarding the choice of indicators was conducted through interviews in three regional offices of Office for the Coordination of Human Affairs (OCHA) in order to gain insight in how well the EER Index results coincide with realities perceived by staff in the field. The findings reveal that in this first version of the EER Index the perceptions of the experts did not coincide very well with the results of the index, and further adjustments of the index are needed. The reason for the inconsistencies regarding for example weighting, choice of indicators and definitions of concepts may lie both in how the research questions were phrased or how the interview process was approached, as well as in the methodology and construction of the EER Index. Inconsistencies may also be attributable to the actual differences in opinions or perceptions of the reality, which is aimed to explore in this thesis. Another finding reveals that important indicators when evaluating environmental emergency risk include industrialisation processes, natural hazards and climate change, as well as environmental dependency for livelihood, deteriorated infrastructure, geographic location and socioeconomic vulnerabilities.

Results also show that currently absent factors such as capacity to respond and a long term factor are desirable in the definition of an environmental emergency.

The investigation process regarding the methods of weighting, normalisation and aggregation was conducted through literature studies which point out some minor methodological adjustments that need to be made.

The findings and suggestions for improvement of the EER Index conclude that initially more research is needed regarding the choice of indicators, both from researchers and practitioners, and also regarding the analytical and mathematical methodology with respect to uncertainty and sensitivity analysis to increase the legitimacy and credibility of the index.

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1. INTRODUCTION

Natural and man-made hazards expose people around the world to risk, and impacts of these risks often severely affect people in developing countries (IASC, JRC & OCHA, 2014). When risks materialize as disasters, the negative consequences have the potential to cause setbacks in years of development gains (ibid.). To save lives, reduce underlying vulnerabilities as well as support sustainable development, there is a need to move from a traditional reactive emergency response to an emergency management and resilience developing framework for managing disaster risks (ibid.).

Before going in to the concept of environmental emergency risk and the rationale for developing the Environmental Emergency Risk Index (EER Index), the definition of what is here meant by the term risk will be presented.

Traditionally the definition of risk is based on the probability of an event and the negative consequences or outcomes associated with that event (Slovic, 2001, p. 19). The concept of risk, as used in the EER Index), has been defined in alignment with the Index for Risk Management (InfoRM) see more information in Appendix A. Risk is in both cases made up by the following three dimensions: hazards & exposure (which includes probability), vulnerabilities and lack of capacities (de Groeve, Poljansek, & Vernaccini, 2014, p. 13; Moriniere (a.), 2014). These components need to be understood in order to enable efficient preparedness and response of the international community (de Groeve, Poljansek, & Vernaccini, 2014, p. 8). Hazards have a potential to cause disasters which in turn have impact on the socioeconomic and the environmental states of a country or region (ibid.). Thus the vulnerability and capacity of said country or region are key factors in determining the severity of hazards (ibid.). The state of the environment has the potential to increase or decrease the risk of a disaster (ibid.). In order to ensure sustainable development as well as the sparing and securing of human lives increased knowledge regarding the links and loops between environmental states and hazards is needed (UNISDR, 2005, pp. 1-2).

As described in InfoRM, if one of the components of risk is not present, then there is no risk (de Groeve, Poljansek, & Vernaccini, 2014, p. 13). Thus in this context there is no risk if a hazard is posing a threat only to environments where no human beings or human values are present or exposed (ibid.).

An environmental emergency is defined as "*a sudden onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that cause or threaten to cause severe environmental damage as well as harm to human health and/or livelihoods*" (UNEP, 2003). In order to be prepared to efficiently respond to such emergencies, an analysis of the associated risks is required (de Groeve, Poljansek, & Vernaccini, 2014, p. 5). Thus factors such as socioeconomic, environmental, technological and natural hazards need to be addressed (ibid.).

Currently there are several similar frameworks for identifying hazards, vulnerabilities and capacity gaps; however they differ from one another in terms of focus area, methodology and set of indicators (Rao, 2013, pp. 1-2). In recent years many international development and humanitarian actors have developed different tools or indices for measuring risk, although not specifically targeting or even covering the aspect of environmental emergencies (Moriniere (b.), 2014).

The EER Index was developed for the JEU to propose a prioritisation index in line with the unit's mandate (Moriniere (a.), 2014). Its purpose is to display which countries are most at risk to environmental emergencies and thus likely to need technical assistance in order to be better prepared (ibid.). Hopes are that the EER Index will also provide an opportunity to support countries on the risk management elements of decreasing vulnerabilities to hazards, and supporting capacities (ibid.). Additionally it is useful as an advocacy tool and a tool for raising interest in disaster-environment linkages by showing the close links between environment and technological hazards as well as the need to include these links into a multi-hazard approach (UNISDR, 2005). In this is included the aims of creating an index that is simple enough to be understood and thus easy to share and lobby for, as well as straight-forward enough to be updated and applied in-house at regular intervals (Moriniere (b.), 2014).

The motivation to why an index such as the EER Index would assist the JEU in prioritising capacity development efforts lies in the fact that the current procedure of prioritisation is based on requests and on the order in which these requests first come to the unit's attention (Moriniere (b.), 2014). However, a number of other factors such as for example the relationship between environmental emergencies and other disaster issues will also play a part in determining whether or not the unit will engage (Joint UNEP/OCHA Environment Unit, 2014). The EER Index will form only one of the elements (ibid.). In order to motivate why efforts are being made in one country and not the other, the JEU has long desired to develop a more evidence-based ground for decision making in these matters (Moriniere (b.), 2014). This evidence base should be scientifically linked to the likelihood of events constituting in themselves, or causing as a secondary effect, environmental emergencies but should also be linked to the current capacity of the country requesting aid (ibid.).

The JEU is now more and more moving towards risk reduction which also in turn gives motives for focusing on capacity development, and in that lays strong incentives for first and foremost targeting those countries in which the risks of experiencing an environmental emergency are the highest, coupled with the lowest capacity to handle such an emergency (ibid.). The vision of the JEU is for countries "to be better prepared, more resilient and able to effectively respond to environmental emergencies" (Joint UNEP/OCHA Environment Unit, 2014). The ways in which the JEU supports UN member states is through: direct engagement with countries with high risk of environmental emergencies, coupled with an opportunity for capacity development; taking the environment into account whenever they take part in inter-agency disaster risk reduction and preparedness missions; and through raising awareness and providing guidance on priority topics through the Environmental Emergency Centre[1] (ibid.).

1.1 AIM

This master thesis aims to investigate to what extent an existing index, i.e. the EER Index, reflects field staff and expert perceptions of environmental emergency risk.

[1] For more information, see http://www.eecentre.org/.

The rationale for the aim of the master thesis is to enable and support prioritisation and efficient use of resources in the work of the JEU and its partners in hopes of, in a longer time perspective, enhancing national preparedness and effective response to environmental emergencies.

1.2 RESEARCH QUESTIONS

In order to fulfil the aim, two research questions were formulated:

1. What environmental indicators are important for ranking country environmental emergency risk?
2. To what extent does the EER Index fit field staff and expert perceptions of realities on the ground regarding environmental emergency risk?

1.3 DEMARCATIONS

The findings of the study are drawn from three targeted regions, Southern Africa, Asia/Pacific and Caucasus/Central Asia by conducting interviews with the JEU in Geneva and with regional offices. It is in these regions that the second research question was applied. To draw general conclusions on a global level more in-depth studies are required.

The drawn conclusions are made based on the EER Index and the study methodology, and cannot be generalised if not otherwise stated (Höst, Regnell, & Runeson, 2006).

2. METHODOLOGY

This study has been based on both literature studies on indices in general and on the current version of the EER Index. These theoretical parts have been supplemented with information gathered from interviews on work experiences in the field in three of the regions in which OCHA work, as well as in the offices of JEU and CADRI in Geneva. The search for data guiding the literature study started with rather wide and generic search terms generating a large amount of information on indices in general, while a more narrow search on specifically environmental emergency indices resulted in very few or no hits. This in part explains the motivation for the construction the EER Index, to fill that gap that apparently exists among current indices in the risk field. The literature study serves as a survey for the thesis, providing a collocation and description of the field of study as it is today (Höst, Regnell, & Runeson, 2006).

2.1 THE INTERVIEWS

The aim of the interviews was to gain insight in existing perceptions regarding environmental emergencies and what factors are the most important to consider when ranking environmental emergency country risk. The results were then analysed to investigate how well the EER Index answers up to the views presented by regional offices and the JEU and CADRI in Geneva respectively. The research method chosen can be described as a case study where several cases, i.e. regions, are studied and where the interviewee is influenced as little as possible (ibid.). Case studies are qualitative, flexible methods of research, as they can be adapted in terms of formulation of questions and sub-questions along the course of the study and as it fits the interviewee (ibid.). Since the cases studied, i.e. the regions, have not been randomly selected, there can be no evidence or statistically validated results from the study (ibid.). The interview and literature studies can also be described as types of surveys where the current situation in the field regarding models and methods used is mapped and one tries to identify what problems exist and need to be solved (ibid.). Surveys most often fall into the category of fix methods of research (ibid.). These two have been the main methods chosen for collecting data in this master thesis, predominated by the case study method, and supported by the survey method. By triangulation, thus combining different research methods or types of data, one gains a more comprehensive picture of the subject studied as well as increase the validity of the results (ibid.).

The selection of informants in this study was influenced by their organisational affiliation, experience in environmental emergencies and location, thus a stratified selection of interviewees was applied (Höst, Regnell, & Runeson, 2006). Five interviews were conducted face-to-face while six were conducted by Skype, ranging in time from 20 minutes to 1 hour. All the interviews were conducted in English. After the first five interviews conducted in Geneva, two additional questions were added for the regional offices, to analyse to what extent different organisational levels are aligned regarding the definition of environmental emergencies, and to investigate if the regions possess additional data sets of value. Also one question was unique for the interviewee from CADRI, specifically targeting lessons learned in capacity development on a national level. The interviews were also recorded to ensure that nothing was missed, and later transcribed into written text.

The data from the interviews were grouped and analysed in steps. First, the transcribed answers were structured in order to be able to compare them; second, all answers were investigated to identify common denominators and themes. Third, the data were compared and analysed with regards to the research questions.

In this study informants have been chosen from three targeted regions in which the JEU works. The general reason for choosing to interview the three OCHA regions of Asia and the Pacific (ROAP), Caucasus and Central Asia (ROCCA) and Southern Africa (ROSA) is that they represent regions which are different enough to give a good overview. Additionally there are individual reasons for each region. In ROCCA the JEU has an on-going project which is aimed at increasing environmental emergency preparedness. In ROSA the JEU has done a number of workshops last year. They have another workshop planned in Mozambique with participation of Angola this year. In ROAP there are a number of high-risk countries located in the region. ROAP are also the office who developed the Global Focus Model and they have a lot of on-going work within preparedness.

The analysis was made on basis of the three regions in terms of comparing existing indicators and rankings in the EER Index with the perception of important indicators for country ranking considered by experts and field staff.

Indicators meant to be used in the policy arena need to be credible, legitimate and relevant for policy priorities (Singh, Murty, Gupta, & Dikshit, 2009, p. 195; de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 11). This demands an inclusive working process taking into account many diverging opinions of future index users as well as from stakeholders (ibid.). This forms one reason for approaching other UN organs than just the JEU or UNEP/OCHA in this initial investigation of the EER Index. The additional organisations participating in the interview study include United Nations Development Programme (UNDP), UNEP and Capacity for Disaster Risk Initiative (CADRI).

Other benefits from this kind of approach of involving a greater number and variety of stakeholders include the contribution of local knowledge and improved cost effectiveness (de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 12). According to de Sherbinin et al. (2013) the institutional ownership of the produced index will also increase with the level of input by potential users and in turn increase the likelihood of the persistence of the index and its policy uptake (de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 11). While de Sherbinin et al. (2013) also argue that involving stakeholder opinions in the process of constructing an index has many times rendered success; the importance of defining who is really a stakeholder is also stressed. de Sherbinin et al. (2013) indicate that often stakeholders are mainly representatives of different branches of organisations or governments as well as from governmental agencies, while casting a wider net for which stakeholders to include in the process would be a strategic way of improving policy uptake. However this type of engagement of stakeholders is more often advocated than actually carried through (de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 12).

2.1.1 THE QUESTIONS

The interviews were based on a predetermined set of questions which was followed in each interview, with formulations adapted to the situation of every interview, thus the interviews were of the semi-structured kind rather than fully structured or open directed (Höst, Regnell, & Runeson, 2006). For the full set of questions, see Appendix B.

The interview questions were focused in three different areas. Initially the questions aimed to establish the informants' background and overall understanding of the concept of environmental emergency. Thereafter the questions focused on deciphering the informants' views of factors to include when evaluating hazards, vulnerabilities and capacities for environmental emergencies. Depending on the informants' background these questions were related to their specific region or globally. Thereafter the experiences regarding priorities in capacity development interventions were explored and what resources in terms of evaluation models and tools and data bases.

2.2 LIMITATIONS

One of the reasons for choosing a qualitative method of research is the possibility and advantage in probing interview answers by asking "Why?" or "How?", and thus gain even more knowledge and insight into the particular interviewees outlook on the matter at hand, but also by the possibility of explaining any ambiguities or misinterpretations of the questions right away and thus generating pertinent and useful input to the EER Index (Foddy, 1993, p. 2; Harris & Brown, 2010, p. 2; Akbayrak, 2000, p. 4; Höst, Regnell, & Runeson, 2006). This increases the flexibility of the method, as well as avoiding the risk of the informant not completing the questionnaire (Höst, Regnell, & Runeson, 2006). Depending on the kind of understanding one strives to achieve through the study, different levels of flexibility are desired, it is however noteworthy that it does not reflect the scientific rigorousness of the method (Mack, Woodsong, MacQueen, Guest, & Namey, 2005).

A disadvantage with the interview method is that it requires somewhat skilled interviewers (Mack, Woodsong, MacQueen, Guest, & Namey, 2005), which may have been a weakness in this case. Instead the authors of this thesis (i.e. the interviewers) learned along the progression of the study how best to formulate the questions and when to ask again or clarify answers. This may have generated better results in the latter of all the interviews conducted. However, since the first interviews were conducted with interviewees more familiar with the EER Index and the scope of the study, these are considered to have both been good practice and to have generated relevant results. At regional level lack of knowledge in these areas might have rendered somewhat more confusion in both the interpretation of the questions and in the relevance of the answers. Altogether, the inexperience of the interviewers is however not thought to have impacted the results of the study in any greater extent.

The main limitation of this study is the inherent subjectivity of the authors and informants during collection of data, analysis of data and interpretation of data. Adding to this is the possibility of misinterpretations due to for example bad sound uptake during interviews and on one occasion potential loss of information when recording was abruptly interrupted and not able to restart. One conclusion of this is that notes should have been taken as a complement to the sound recordings to have a well-established routine for note taking. This might have facilitated even more reliable results.

Furthermore, the definitions of the different concepts such as environmental emergency and vulnerability that each informant holds differ somewhat. During interviews with the regional offices, the definition used by UNEP and subsequently the JEU was presented but there is still a chance of informants not fully perceiving that definition but continuing answering the following questions according to their own definition. This risk is especially high when considering that some informants did not fully agree with the definition presented.

Other limitations of the method include the larger amount of time demanded in conducting an interview than in for example a questionnaire (Foddy, 1993; Akbayrak, 2000, pp. 2-3; Höst, Regnell, & Runeson, 2006), which might have influenced the number of participants in the study. However, the personal relationship created through an interview is thought to increase the willingness to contribute to the development of the index (Harris & Brown, 2010, p. 2). Moreover, the difference in number of informants participating from each region, and how informants were selected pose a challenge as to how the findings from the interviews can be generalised. In total 11 interviews were conducted, whereof five were in the JEU office in Geneva, three from different organisations in ROCCA, one from ROSA and ROAP respectively.

The study makes no claims on being statistically generalizable, as this is an inherent consequence from using case studies as research method (Höst, Regnell, & Runeson, 2006), for entire regions or other regions in the world, but focuses on generating a greater understanding for how the EER Index can be investigated, modified and hopefully improved to better reflect the perceived reality and suit the needs of the intended users.

2.3 INTRODUCING THE REGIONS AND THE JOINT UNEP/OCHA ENVIRONMENT UNIT (JEU)

The interviews in this thesis will target the following three of the OCHA regions, the region of Caucasus and Central Asia, the region of Asia and the Pacific and the region of Southern Africa. All three regions are exposed to hazards of different kinds, and possess different vulnerabilities and capacities to handle the effects of those hazards. In this section the JEU and the targeted regions will be briefly introduced. For more information about the other organisations from which interviewees were selected, see Appendix C.

2.3.1 JOINT UNEP/OCHA ENVIRONMENT UNIT (JEU)

JEU is the United Nations emergency response mechanism that coordinates and mobilises international assistance to countries facing environmental emergencies and natural disasters with significant environmental impacts (Joint UNEP/OCHA Environment Unit, 2013). This thesis has been supported both by Lund University and the JEU in investigating the first versions of the EER Index.

JEU is a partnership between UNEP and UNOCHA and bridges the gap between emergency prevention, preparedness and response, and disaster management stakeholders by supporting information sharing, facilitating collaborative activities between partners and increasing the range of stakeholders involved in environmental emergencies management (Wexler, van der Kolk, Mohapatra, & Agarwal, 2012, pp. 678-679). This is made possible by combining the environmental expertise of UNEP and the humanitarian response network of UNOCHA in striving to fulfil JEUs mission of aiding countries requesting assistance in preparation and response when experiencing environmental emergencies (ibid.).

The mission of the JEU is focused on three main areas: response, preparedness and integrating environment in humanitarian action (UNISDR, 2013). The response actions include activities in the first hours after an environmental emergency such as mobilising experts and equipment for conducting rapid assessments, testing for the presence of hazardous materials, analysing the possible effects on communities, and aiding national authorities in developing strategies to respond (ibid.). Preparedness is integrated in the JEU mission through activities which aim to increase preparedness to potential risks and impacts of environmental emergencies in both communities and other key actors such as governments, disaster responders and industries (ibid.). The JEU also works to ensure that environmental issues are an integrated part of all elements of humanitarian response through strategic planning, contingency planning, humanitarian financing, and performance monitoring and evaluation (ibid.).

2.3.2 REGIONAL OFFICE OF ASIA AND THE PACIFIC (ROAP)

The OCHA regional office for Asia and the Pacific supports 36 countries and 14 territories located in the world's most disaster prone zone (OCHA (a.), n.d). OCHA works in particular with 12 countries in this region due to their high exposure to hazards and low capacities to respond (UNOCHA, 2012).

The most common hazards include natural hazard such as earthquakes, tsunamis, tropical storms, flooding, landslides and volcanic eruptions (OCHA (a.), n.d). The severity of these events is continuously becoming more severe and frequent due to both climate changes and an increasing population in the region (ibid.).

2.3.3 REGIONAL OFFICE OF CAUCASUS AND CENTRAL ASIA (ROCCA)

The OCHA regional office for Caucasus and Central Asia is made up of 8 countries with a combined population of 77.5 million people and a land area larger than Western Europe (OCHA (b.), n.d). The region is highly susceptible to both natural and manmade hazards such as earthquakes, flash floods, civil conflicts, drought, cold winters, climate change, global food and energy price spikes, and national and ethnic tensions (ibid.). These risks have severe effects on vulnerable communities (ibid.).

2.3.4 REGIONAL OFFICE OF SOUTHERN AFRICA (ROSA)

The OCHA regional office for Southern Africa consists of 15 countries is most characterised by natural hazards such as tropical cyclones and floods as well as increasingly intense, frequent and severe epidemics (OCHA (c.), n.d). The high prevalence of HIV/AIDS in the region further complicates the impact of the disasters as the diseases increases the vulnerability with the people (ibid.).

3. THEORETICAL BACKGROUND

In this section the subject of theoretical background and scientific motivation for indices will be covered. Key factors, such as normalisation, weighting and aggregation will be analysed in order to localise which decisive factors exist for constructing a meaningful index together with the intrinsic relationships and interdependencies between these factors.

Around the world, different performance indices are used to measure and manage progress and inform policy decisions to reach set goals within a range of different areas (de Sherbinin, Reuben, Levy, & Johnson, 2013, pp. 4-5; Barnett, Lambert, & Fry, 2008). This is true for many different sectors of society, economic and social as well as for environmental management (ibid.). In the environmental sector there are still issues regarding what should be measured to provide a good indication of both current status and progress of initiatives taken, and lack of data is almost always a problem (de Sherbinin, Reuben, Levy, & Johnson, 2013, pp. 4-5). Additionally there are problems regarding how data should be normalised, aggregated and weighted into an index as well as which of existing indices best describe the reality of the environmental health of the world (ibid.).

Since the Earth Summit in 1992 which gave a global voice to the sustainable development movement, there have been focused efforts to identify and highlight key environmental indicators, which have yielded positive achievements in some areas while others have fallen flat (Hsu, et al., 2014, p. 13). Today there are signals, such as for example growing concern of the emerging threats stemming from environmental risks and governmental pressure regarding wise investments of limited resources, showing that the world is ready to step up their environmental performance and protect the environment by establishing a set of goals to strive for in order to achieve sustainable development (ibid.). At the same time there is more evidence than ever showing that, to achieve progress in the international community regarding environment, human health and financial development, management and measurement of goals need to be aligned (ibid.). All too often the two however misalign, causing progress set back and the environmental conditions decreased or reduced (ibid.).

Even though there have been efforts that could be used for tracking policy responses and environmental problems, many existing environmental indices have failed to earn statuses for environmental performance to inform policy decisions in the scale of gross domestic product (GDP) and other social development models (de Sherbinin, Reuben, Levy, & Johnson, 2013, pp. 4-5).

The use of indicators to measure and manage environmental challenges is increasing worldwide, both on global and local scales (de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 7). There has thus far not been too much success for existing environmental indices, due to that there is still a large lack of consensus about what they need to measure in the environmental sphere and also due to the large abundance of opinions regarding the usefulness of environmental indicators in the policy process (ibid.). Therefore assessments of the current use of indicators need to be conducted, and thereby also identifying in which ways these environmental indicators can have an impact on policy processes and decision making in management (ibid.).

3.1 INDEX

An index is a mathematical combination of indicators representing different aspects of an issue one aims to explain in the analysis (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 7). Constructing indices is always subjected to a certain degree of subjective judgement in terms of choice of indicators, method of aggregation, weighting, how to treat the case of missing values or lack of data etc. (ibid.; Singh, Murty, Gupta, & Dikshit, 2009, p. 197). This leaves a window of opportunity to manipulate the outcomes of the index, unless the construction process is conducted and presented in a transparent way (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 7). In this process it is also important to identify where subjective or possibly incorrect assessments have been made and to use uncertainty and sensitivity analysis during the process to gain useful information also on the definition of quality for the indicators, to be able to assess the subsequent ranking (ibid.).

An index is a quantitative or qualitative measure derived from a series of observed facts that can reveal relative positions in a given area (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 13). Indices are useful in identifying trends and drawing attention to particular issues (ibid.). They can also be helpful in setting policy priorities and in benchmarking or monitoring performance. The index should ideally measure multidimensional concepts which cannot be captured by a single indicator (ibid.).

Indices provide a simple comparison used to illustrate complex and sometimes elusive issues in wide-ranging fields, e.g. environment, economy, society or technological development (ibid.; Singh, Murty, Gupta, & Dikshit, 2009, p. 191). It often seems easier for the general public to interpret indices than to identify common trends across many separate indicators, and they have also proven useful in benchmarking country performance (ibid.).

However, indices can also send misleading policy messages if they are poorly constructed or misinterpreted (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 13). Therefore indices must be seen as a means of initiating discussion and stimulating public interest and thus their relevance should be gauged with respect to constituencies affected by the index (ibid.). In the environmental arena there has however been much discussion about what to measure, what best describes the state of the world and how selected indicators should be aggregated to form indices that can be appropriately used in policy decision (de Sherbinin, Reuben, Levy, & Johnson, 2013, p. 5).

Ebert & Welsch (2004) have described what they define as a meaningful environmental index, which is characterised by being independent of which allowed transformation method is used for the different variables describing the environmental state (Ebert & Welsch, 2004, p. 270). This means that the index should be free of ambiguity regardless of which unit is used for measurement of the environmental issue at hand and regardless of the allowed transformation method chosen (ibid., p. 271). Allowed transformation types are categorised into comparability and measurability, which in turn determine whether or not an index is meaningful (ibid.).

Another way to express the meaningfulness of an index is in terms of its quality and its ability of performing the tasks for which it was developed (Pelling, 2004, pp. 11-12; Kaly (a.), Briguglio, McLeod, Schmall, Pratt, & Pal, 1999, pp. 28-29). For an index to be meaningful it has to measure its target effectively and also only measure that (ibid.). The index should allow the results to be comparable on different spatial scales, and the results and the index should be intuitively comprehensible (ibid.). This is thus what an index should always aspire for (ibid.).

3.2 STEPS FOR CONSTRUCTING AN INDEX

The ideal course of action in the construction of an index is to divide the process into ten steps according to Nardo et al. (2008) which have here been modified and supplemented by the authors with additional literature findings:

1. Theoretical framework
2. Selecting data and indicators
3. Imputation of missing data
4. Multivariate analysis
5. Normalisation
6. Weighting and aggregation
7. Uncertainty and sensitivity analysis
8. Back to the real data
9. Links to other variables
10. Visualisation of the results

Each step is equally important and consistency in all steps is desirable (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 19). Actions made in one step may have consequences for the following steps, which advocates for carefulness and thoughtfulness in the construction process (ibid.). Since the index will be confronted with scepticism this is of paramount importance, coupled with transparency in the choice of indicators, the methodology and the data sets used (ibid.).

The ten steps proposed by Nardo et al. (2008) have been modified and supplemented by the authors with additional literature findings. These theoretical steps will in forthcoming sections be compared to the practical example of the EER Index.

3.2.1 STEP 1: THEORETICAL BACKGROUND

When constructing an index a sound theoretical background forms the baseline (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 20). In the baseline it should be unambiguously defined what is being measured and through which indicators, weighting the indicators after their relative importance (ibid.). The construction of an index should be guided by what one aims to measure and not on which indicators are available (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008; Cardona, et al., 2003). Another aspect is the understanding of how risk management objectives and goals are decided (Cardona, et al., 2003).

The framework will aid in the selection and combination of the indicators by identifying what is to be measured and its underlying processes, and compiling a list of criteria for the underlying indicators (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 20).

3.2.2 STEP 2: SELECTING DATA AND INDICATORS

In the second step, data for the index indicators is selected. The general lack of international comparable quantitative (hard) data often leads to the usage of qualitative (soft) data from surveys or policy reviews instead (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 23). When data is missing or scarce one could use proxy indicators to get sufficient measurements. This could be done with the involvement of experts and stakeholders (ibid.). The accuracy of the proxy should be analysed through empirical analysis, such as bivariate and multivariate analysis, and through sensitivity analysis (ibid., Singh, Murty, Gupta, & Dikshit, 2009, p. 195). Bivariate analysis measures the correlation between pairs of indicators to identify overlaps of indicators or latent indicators in the set in order to minimise the number of indicators (Singh, Murty, Gupta, & Dikshit, 2009, p. 195).

The number and the nature of the indicators in the index should first be determined through theory, empirical analysis, pragmatism or intuitive appeal or by some kind of combination of these methods (Singh, Murty, Gupta, & Dikshit, 2009, p. 195). In order for the indicators to be "good" or "satisfying" they should be selected based on their analytical soundness, measurability, country coverage, relevance to what is being measured and the relationship to each other (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 23). Selecting indicators demands a certain balance between simplification and complication (Singh, Murty, Gupta, & Dikshit, 2009, p. 195).

Another aspect to take into consideration, especially when creating an index that largely builds upon existing indices and their indicators, is the possibility of indicators having different meanings in different contexts (Birkmann J. , 2007). This consideration is important for efficiency and cost effectiveness in indicator choices, but also as indicators may imply different things in different local contexts (ibid.). For example some other indicators such as the number of 'hospital beds per 1000 people' imply a certain model of health infrastructure which might not be appropriate for poor rural areas, where the model of 'doctor on a bicycle' is much more efficient and cost effective (ibid.).

COMPARABILITY VS COMMENSURABILITY

There are generally five different concepts when relating indicators to one another, comparability, commensurability, non-comparability, incomparability and incommensurability. These definitions are used interchangeably by some while others make a distinction between them (Hsieh, 2007). To make a correct analysis, it is important to know the definitions used in the literature studied in order to make correct interpretations of them. Since the definitions of these concepts are rarely explained, the authors of this thesis have made a thorough examination of this subject in order to interpret the definitions and define the ones used in this master thesis, see Appendix D.

Indicators can, as mentioned above, either be comparable or non-comparable. If the scientific relationships between the indicators are known and the indicators are usually describing a specific environmental issue or theme, the variable units can often be aggregated by their individual contribution to the specific issue (Ebert & Welsch, 2004). Indicators are comparable when the scientific relationships between them are known in such a way that aggregation is possible even if they are measured in different units (ibid.). In the other case, where the scientific relationships between indicators are not known and thus cannot compensate for or over bridge the fact that they are measured in different units, the indicators are called non-comparable (ibid.) and problems may arise. This can be due to a vague definition of the phenomenon studied and it not having generally valid links to the indicators that are presumably contributing to it (ibid.), e.g. environmental emergency risk. The comparability of scales means that the scientific relationships between the indicators are known, thus different scales are not meaningful to aggregate due to their different scales but also indicators of the same scale can be not meaningfully comparable due to the lack of established scientific relationship between them (ibid.).

RATIO SCALE VS INTERVAL SCALE

The main challenge in constructing environmental indices or indices is the fact that indicators are measured in widely differing units and scales within the environmental area (Ebert & Welsch, 2004). Ratio scale indicators have a fixed zero point, and a zero in this scale means that there is none of that indicator, while in the case of interval scales there is no fixed zero point and a zero of that indicator does not mean that there is none of that indicator (ibid.). Consider for example the case of mass which is measured in ratio scales, where when there is 0 pounds or kilograms of a substance there is by definition no substance (ibid.). On the contrary, zero in temperature measured in interval scales such as Celsius or Fahrenheit does not mean that there is no temperature, while when measured in Kelvin which has an absolute zero; there is by definition no temperature at 0 degrees (ibid.).

The main problem in environmental indices coupled with these different scales, manifested in measuring relevant indicators, is that different aggregation methods may generate different rankings of the environmental states, which is undesirable according to the definition of a meaningful environmental index (Ebert & Welsch, 2004). Ebert & Welsch (2004) show that for ratio scale indicators arithmetic mean as a tool for transformation and aggregation will not generate a meaningful environmental index, while geometric transformation or aggregation will keep rankings constant and thus generate a meaningful index. In the case of interval scale indicators both arithmetic and geometric aggregation and transformation may not be meaningful since the rankings of the environmental states may be altered (ibid.).

Table 1 The table shows the aggregation rules proposed by Ebert & Welsch (2004), adapted from Singh, Murty, Gupta, & Dikshit (2009), in constructing meaningful environmental indices based on the scale and level of comparability between the indicators included in the index.

	Aggregation rules for variables by Ebert & Welsch (2004)	
	Non-comparability	Full comparability
Interval scale	Dictatorial ordering	Arithmetic mean
Ratio scale	Geometric mean	Any homothetic function

Forthcoming parts of this study will not discuss the aggregation methods dictatorial ordering and homothetic functions further due to their lack of applicability in the EER Index.

3.2.3 STEP 3: IMPUTATION OF MISSING DATA

If values or data are missing an imputation is needed in order to complete the dataset and continue with the construction of the index (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 24; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005). The missing values are estimated based on available information and the reliability of each imputed value is measured to assess the impact of the imputation on the results of the index (ibid.).

Values can be missing in either a random or a non-random pattern (ibid.). The missing data can follow one of the three patterns described below (ibid.):

1. **Missing Completely At Random (MCAR)**, the values are independent of the indicator of interest or any of the other indicators in the data set, meaning that the missing data for one indicator are estimated to be on average the same as the data that is present for the indicator and this is also true for all the other indicators in the index. Thus the data measured are not good representatives of the indicator one aims to explain.
2. **Missing At Random (MAR)**, the missing values are independent of the measured indicator or indicator of interest, but depend conditionally on one or more of the other indicators in the data set.
3. **Not Missing At Random (NMAR)**, the values are only dependent on themselves and are thus missing due to a certain factor.

To be able to impute values the missing data must belong to either the first or the second of the above categories (ibid.). However, it is very hard to determine whether missing data belong to any of the first two categories or to the third category since there is no statistical method through which one can decide if values are missing in a random or non-random fashion (ibid.). When a data set has NMAR values they have to be explicitly modelled and included in the analysis which is very difficult and could imply ad hoc assumptions that are likely to influence the results (ibid.).

To deal with missing data three different methods are generally used (ibid.). The first is called case deletion or complete case analysis (ibid.). This method simply neglects the missing data (ibid.). That means that the dataset only becomes unbiased if the ignored values are a random sub sample of the original sample (MCAR) (ibid.). If a dataset has more than 5 % missing values, this method cannot be used (ibid.). This method is the one used in the EER Index. The second method is called single imputation and examples of this method could be mean/median/mode substitution, regression imputation, hot-and cold-deck imputation and expectation-maximisation imputation (ibid., p. 25). The third method is called multiple imputation method or Markov Chain Monte Carlo algorithm (ibid.).

3.2.4 STEP 4: MULTIVARIATE ANALYSIS

In this step, the structure of the data is investigated to assess its suitability for the intended purpose and thereby provide guidance to the subsequent methodological choices (e.g. weighting and aggregation) (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 25). If indicators are chosen without being thoroughly analysed with respect to interrelationships the resulting index might send misleading messages to decision makers and the general public (ibid.). During the process of constructing the index, data can be divided into two dimensions and analysed accordingly (ibid.). The two dimensions are:

1. **Indicators:** This dimension is the one used in the EER Index. During the analysis of this dimension the available indicators are evaluated in terms of sufficiency and its appropriateness of describing what is being measured (ibid.). This can be done either with the opinions of experts or with the statistical structure of the data set by using different analytical approaches, such as the Principal Components Analysis (PCA), Factor Analysis (FA) or the Cronbach coefficient alpha (C-α) (ibid.).
2. **Cluster of countries:** This dimension is used when the data of different countries are similar for the indicators, these countries are then clustered together and analysed statistically (ibid.).

3.2.5 STEP 5: NORMALISATION

Both normalisation and weighting pose a problem since these methods aim to compare indicators that are usually not easily compared (Böhringer & Jochem, 2007, p. 5). This can be handled either by converting all units to a new unique scale, transforming and expanding them or by converting all indicators to a new scale by expanding (ibid.).

As long as one chooses indicators in a proper manner, that is belonging to one of the four groups: interval scale or ratio scale and comparable or non-comparable, these can be aggregated according to one of the methods presented by Ebert & Welsch (2004), see table 1. Note that all indicators must belong to the same of the four groups in order to be aggregated into a meaningful, unambiguous index (Böhringer & Jochem, 2007, p. 2).

Normalisation, that is converting different units into a common scale, is needed whenever indicator values are incompatible or are measured in different units (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 29-30; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 11). If indicators are expressed in different scales, i.e. ratio scale and interval scale, the selected normalisation method should remove the scale effect from all indicators at the same time (ibid.). Skewed data should also be identified and accounted for (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 15). Skewed data means that the data tends to have a long tail on either side of the normal distribution (Buthmann, 2010).

Normalising indicators is an attempt to eliminate the effect and bias of the measurement unit and the range of the measurement results on the final ranking (Ebert & Welsch, 2004, p. 281). Most normalisation procedures follow either the ranging or the standardisation classes (ibid.). Ranging expresses the indicator values relative to reference values; these can be either target levels as in the Environmental Performance Index (EPI)[2] or base levels, or as in the case of EER Index relative to the maximum indicator value in the set (ibid.). Standardisation on the other hand subtracts the mean value of the indicators from the indicator at hand and then divides it by the standard deviation (ibid.).

[2] For more information regarding the EPI, please visit http://epi.yale.edu/

Normalisation does, however, not simplify the task of aggregating values that are inherently non-comparable and their subsequent orderings in indices. More so, the different normalisation methods and the lack of standards and scientific basis for choosing an appropriate method may introduce further ambiguities (Ebert & Welsch, 2004, p. 12). In the case of ratio scale non-comparable indicators values can be aggregated without previous normalisation through creating a geometric mean of the crude data, and by doing so create a meaningful index (ibid.).

SKEWED DATA

To deal with skewed data, a transformation to turn data into the shape of the normal distribution is necessary (Box & Cox, 1964, p. 211; Buthmann, 2010). This transformation is performed on the data before selecting an appropriate normalisation method (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 11). The Box-Cox Power Transformation identifies an appropriate exponent, lambda (λ), to use in order to get guidance on which transformation method should be used (Box & Cox, 1964, p. 213; Buthmann, 2010). This transformation is not a guarantee for achieving a normal distribution, since it does only check for the smallest standard deviation (Buthmann, 2010). It assumes that the transformed data has the highest likelihood to be normally distributed when the standard deviation is the smallest (ibid.). The method only works if the data is positive and greater than zero (ibid.). If data is not, one could add a constant to all the data and still use the same method (ibid.).

NORMALISATION METHODS

Some normalisation procedures are invariant to changes in units as they provide the same ranking regardless of the unit, while others are not (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 84; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 44). Using a non-invariant normalisation procedure could result in different outcomes for the index (ibid.).

In the EER Index, the method used is invariant and called the **Min-Max** or **Re-scale method** (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 44). The Min-Max or Re-scale method subtracts the minimum value from the indicator value and then divides this with the range of the indicator values (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 47-48). This results in an identical range for the indicators in the index (ibid.). The method can thus widen the range of indicators situated in a small interval and by that increase the effect on the index explicitly (ibid.). However, extreme values or outliers can distort the indicators (ibid.).

Other normalisations methods include ranking, standardisation/z-scores, distance to a reference, categorical scale, indicators above or below the mean, methods for cyclical indicators, balance of opinions, and percentage of annual differences over consecutive years (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005). For more information regarding normalisation methods, see Appendix E.

3.2.6 STEP 6: WEIGHTING AND AGGREGATION

Weighting of indicators is a controversial issue, some argue that intentional weighting should as far as possible be avoided (Singh, Murty, Gupta, & Dikshit, 2009, p. 197), while it is by most acknowledged that where no weighting is deliberately assigned to indicators, an implicit equal weighting is (Moriniere (b.), 2014; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 31). Since there are currently no widely established methods for normalisation, weighting or aggregation in indices, one idea could be to consult experts in an open discussion in order to derive appropriate weights and methods for the index (Böhringer & Jochem, 2007, p. 5). This will however risk rather subjective weightings, but on the other hand statistically calculated weighting might just as well give high weights to matters that are not prioritised in political or decision making situations, which will make the index yet more unaccepted (ibid., p. 5).

WEIGHTING

Weighting can reflect priorities, reliabilities or other characteristics of the indicators (Jacobs, Smith, & Goddard, 2004, p. 44). The meaning of weight is to reflect the relative importance of indicators; however it will always be exposed to a certain degree of subjective judgement and thus have the power to enhance the objective of constructing the index in the first place (ibid.). Since weighting has such large impact on the resulting index, especially when countries excel or fail in an indicator to which high weight has been assigned, it is important to keep this process transparent (Jacobs, Smith, & Goddard, 2004, p. 46; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 12).

In the weighting process the relevance of the underlying data for an indicator needs to be evaluated in terms of meaningfulness of the index (Hsu, et al., 2014, pp. 19-20; Jacobs, Smith, & Goddard, 2004, p. 46; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 12). Of course, one should always aspire to find perfectly fitted data, but if that is not possible one could adjust the weights according to the relevance and reliability of the data, thus data with few missing values, large coverage and sound values will be rewarded higher weights (ibid.). This could however result in rewarding of data that is readily available and easy to gain access to, and punish data that is harder to identify and measure (ibid.).

WEIGHTING METHODS

Implicit weights are often introduced in the scaling of indicators, but in addition explicit weights can be assigned. The predominately chosen weighting method is **equal weighting (EW)** of all indicators (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 31-32). This method is often used when there are no statistical or empirical reasons for using another method, when enough is not known about the indicators' relationships or when consensus of an alternative cannot be reached (Jacobs, Smith, & Goddard, 2004, p. 46; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 31; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 55). Testing for correlation and choosing only indicators which have low correlation will minimise the risk of double counting (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 32; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 55). Minimising the number of indicators in the index could also be of use for other reasons such as transparency and simplicity (ibid.).

Some methods of weighting are based on statistical models such as **principal components analysis (PCA)** combined with **factor analysis (FA)**, b**enefit of the doubt (BOD)** and **the unobserved components model (UCM)** (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 32).

Other methods of weighting are based on a participatory approach and incorporate various stakeholders such as experts, the public and politicians (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 31). These methods work best on a national level when there is a well-defined basis, on an international level the results could be contradictory (ibid.). Examples of these kinds of methods are **the budget allocation approach (BAP)**, **analytical hierarchy process (AHP)** and **the conjoint analysis (CA) (ibid.).** For more information on weighting methods, see Appendix F.

In the EER Index, a form of the BAP approach is used. In the BAP approach experts on a given subject such as education or the environment, are asked to allocate a "budget" of 100 points to the indicators and distribute the points among them, giving most points to those indicators they feel are the most important to stress according to their own experience and judgement (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 66-68; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 100; Jacobs, Smith, & Goddard, 2004, p. 46). The weights are calculated as the average budgets (ibid.). An alternative to this method could be to ask the general public what their degree of concern is regarding certain issues related to the indicators, since it is more difficult to ask the public to allocate points on individual indicators (ibid.). These polls are easy to use, inexpensive to carry out and create consensus for policy actions (ibid.).

The advantages of the BAP method are increased transparency, legitimacy, a spurred discussion for policy actions as well as the method not being particularly time consuming (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 96). Disadvantages of the method could be the reliability of the weights, i.e. they reflect a specific local context (as in environmental problems) and cannot be directly applied to other contexts, or that using to many indicators can induce cognitive stress of the experts (the optimal maximum of indicators are 10 -12) (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 32). There is also a risk that the subjective opinion of the experts will result in giving higher weights to the indicators that they feel are urgent to influence politically rather than the actual importance (ibid., p. 101). It is also necessary to bring together experts from a wide spectrum of knowledge and experience to ensure a proper weighting (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 96; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 66). This encourages further efforts in building on the EER Index by aiming for more input and more widespread participation in the international community, as well as further peer review.

The choice of weighting method will affect which aggregation method can be used (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 32-33). The linear aggregation is useful when the indicators have the same measurement unit if the mathematical properties are taken into consideration (ibid.). Geometric aggregations are to be used if some degree of compensability between the indicators is wanted (ibid.). Linear aggregation reward indicators proportionally to the weights while geometric aggregations reward the countries with higher scores (ibid.).

AGGREGATION

After the normalisation and weighting have been decided, the proper aggregation procedure isperformed (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 12). Correlation and compensability issues among indicators need to be considered and either corrected for or treated as features of what is being measured that need to be retained in the analysis (ibid.).

The issue of aggregation is tightly connected to the weighting of indicators (ibid.), as described in the previous chapter. There are different methods to apply for aggregation, for example linear aggregation which means summing up the indicator values, geometric aggregation which implies multiplication of variable values, and other non-linear methods including for example multi-criteria analysis (ibid.). Each of the different methods is based on specific assumptions and will give rise to certain consequences (ibid.).

Linear aggregation can be used when all the indicators are measured in the same unit and when other fuzziness or ambiguities regarding the indicator scales have been accounted for and neutralised (ibid.). Linear aggregation also implies that lack or deficiency in one indicator can be fully compensated by high performance in another indicator value (ibid.).

Geometric aggregation is appropriate for indicators expressed in only positive values and in ratio scales, as elaborated upon above (ibid.). Geometric aggregation includes only partial compensability as opposed to linear aggregation (ibid.). The lower the values of the index sub-indicators, the lower the compensability (ibid.). This however presupposes that the index has been constructed in a way such that high values of the index are good whilst low index results are bad (ibid.).

To make use of either linear or geometric aggregation there can be no conflicts or synergies between the indicators (ibid.). One of the differences between the two is that linear aggregation rewards the sub-indicators proportional to the assigned weights while geometric aggregation gives higher rewards to countries with high scores (ibid.). Both linear and geometric aggregation build on the idea that there can be a kind of trade-off between indicators, thus deficiencies in some indicators can be offset by excess in others (ibid.).

When it comes to complex matters with highly different dimensions in indicators, such as environmental indices where numbers from very different spheres of society (economic, social and environmental), and goals are equally legitimate and important this may not be the best approach (ibid.). If an increase in economic performance for example cannot compensate for environmental degradation, then neither of the linear logics presented are appropriate to use (ibid.). Instead a non-compensatory **multi-criteria approach** will be more suitable (ibid.). This will ensure that indicators do not compensate for each other by giving a definite form to the idea of compromising between more than one legitimate goal (ibid.).

Below the compatibility between the weighting and aggregation methods are visualised:

Table 2 Compatibility between weighting and aggregation methods according to Nardo et al. (2008). For more information on weighting methods, see Appendix F.

Weighting methods	**Aggregation methods**		
	Linear	**Geometric**	**Multi-criteria**
EW	Yes	Yes	Yes
PCA/FA	Yes	Yes	Yes
UCM	Yes	No	No
BOD	Yes	No	No
BAP	Yes	Yes	Yes
AHP	Yes	Yes	No
CA	Yes	Yes	No

3.2.7 STEP 7: UNCERTAINTY AND SENSITIVITY ANALYSIS

The robustness of an index can be tested with uncertainty and sensitivity analyses (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008). The robustness is expressed in terms of the mechanism for including or excluding an indicator, the normalisation scheme, the imputation of missing data, the choice of weights and the aggregation method (ibid.). The sensitivity analysis is conducted on the assumptions of the index and determines what sources of uncertainty are more influential in the scores and/or ranks (ibid.).

Uncertainty analysis and sensitivity analysis are two powerful tools for ensuring that the index results of country rankings are robust and properly assessed as well as for providing input to the definition of the quality of countries' indicators (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 12).

The subjectivity of the assumptions of data errors and choices of mechanism for inclusion or exclusion of indicators, transformation and/or trimming of indicators, normalisation method, method for imputation of missing data, choice of weighting and the choice of aggregation method in indices are often criticised (Singh, Murty, Gupta, & Dikshit, 2009, p. 197; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 34). Uncertainty and sensitivity analyses can here provide input as to how robust the index is and increase its transparency and thereby also increase its use for policy decisions (ibid.).

The difference between the sensitivity analysis and the uncertainty analysis is that that the appointed value of indicators affect the resulting value of the index, which can be analysed in sensitivity analysis, while the uncertainty boundaries of each indicator affect the variance of the result of the index. The latter can be analysed in an uncertainty analysis. The degree of uncertainty in each indicator will have to be estimated in order to estimate the resulting uncertainty in the index, which will as mentioned above also increase the transparency of the index construction process.

Usually the two analyses are used separately and seldom in combination, although this has proven to be more powerful (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005; Singh, Murty, Gupta, & Dikshit, 2009). Using these tools will convey the uncertainties and ambiguities in the index in a more transparent and easily defensible way (ibid.) as an index number with its related confidence bounds. Conducting these analyses could reduce the risk of the index being used for non-robust policy messages or send misleading messages (ibid.). The analyses can also increase the information on whether or not the index shows if the countries are measuring something meaningful or not (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 13).

3.2.8 STEP 8: BACK TO THE REAL DATA

This step goes back to the dataset of the index and checks for correlation and causality between indicators and also identifies if the index results are overly dominated by a few indicators (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 35, 132). This explains the relative importance of the indicators and what is driving the results of the index (ibid.). Indices should be transparent and fit to be decomposed into their underlying indicators or values (ibid.). Transparency is fundamental to good analysis and policymaking (ibid.).

3.2.9 STEP 9: LINKS TO OTHER INDICES OR INDICATORS

Attempts should be made to correlate the index (or its dimensions) with other well-known aspects related to the concept that the index aims to measure, and with the final result of the index (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 39). This step is needed in order to develop data-driven descriptions of the index based on the results (ibid.). This investigates the explanatory power of the index, that is, how closely linked the result of the index really is to what is desirable to measure (ibid.).

3.2.10 STEP 10: VISUALISATION OF THE RESULTS

Indices can be visualised or presented in a number of different ways, which can influence their interpretation (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 40-41; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 102). The final step will be to identify a coherent set of presentational tools for the targeted audience, to select the visualisation technique which communicates the most relevant information and to present the index results in a clear and accurate manner (ibid.).

One point that might need extra reflection in the results of an index is grading. Grading the risk of each country only in relation to other countries, it is hard to know if the overall risk is middle, high or low (Birkmann J. , 2007). Where there is no risk baseline or risk reduction goal either for the indicators or for the resulting index, the classification of the risk is made only relative between countries based on the differences between them (ibid.). Then it must be decided what is a tolerable level of risk. It might be an idea to establish a risk baseline required for interventions or capacity development interventions, perhaps based on one of the initial results from the index, in order to have a point of reference for future decision makings and in order to increase cost effectiveness.

4. EER INDEX STEP BY STEP

In the following section the steps for constructing the EER Index are described as expressed by Moriniere (2014) in the first draft version of the EER Index methodology. Efforts have been made to connect these to the extended 10 step guide adapted from Nardo, Saisana, Saltelli, Tarantola, Hoffman & Giovannini (2008), to show a practical example of how to construct an index, in reference to previous section. For other examples of indices that precede the EER Index, see Appendix A.

4.1 EER INDEX IN GENERAL

The EER Index was developed in three steps, namely laying the foundation, compiling data and analysing (Moriniere (b.), 2014). These three steps roughly correspond to the steps 1-3, 5-6 and to some extent to the steps 8-10 in the extended 10 step guide adapted from Nardo et al. (2008).

Firstly, the choice of framework and structure was made, based upon the same principles guiding the InfoRM Index (Moriniere (b.), 2014), for more information see Appendix A. This foundational principle builds upon the notion that risk is a function dependent on three factors (ibid.). These factors are hazards, vulnerabilities and capacities and were accepted as core domains for which it was then needed to find key components in the area of environmental emergencies (ibid.).

The search for these key components of environmental emergencies was conducted through interviews and literature reviews which resulted in eight components for which measurements (also referred to as indicators) were sought (ibid.). These eight components include technological hazards, sudden natural hazards, human hazards (conflict), natural resources vulnerability, human vulnerability and capacity (InfoRM) (ibid.). This corresponds to what is described in step 1 in the extended 10 step guide adapted from Nardo et al. (2008).

Thereafter existing risk indices found in research were investigated for measurements/ indicators to the components proposed above, concluding that none of the indices targeted environmental emergencies specifically, and that there were indicators not addressed in necessary extent (Moriniere (b.), 2014). These indicators belong to the components of technological hazards, vulnerability of natural resources and a measure of national capacity to adequately manage the physical environment (ibid.). The addition of information on these components is considered to be the added value of the EER Index (ibid.).

After the risk indices were analysed and cross checked for correlations, it was concluded that many of the indices covered the same information (ibid.). Therefore the number of indices used in the EER index could be reduced without losing any of the variance among them (ibid.). In steps 8 and 9 adapted from Nardo et al. (2008) correlation between indicators and other variables and among variables respectively is also suggested, however for other reasons entirely, see sections 3.2.8 and 3.2.9.

Secondly, when indicators had been selected, coverage criteria for their inclusion in the index were determined (Moriniere (b.), 2014). Only indicator data that fulfil most of the criteria were included in the EER Index (ibid.). However, how many of the following criteria must be fulfilled is not clearly stated:

- Global coverage, meaning that the indicator is available for a number (determined by the JEU) of the 191 countries covered in the InfoRM.
- Geographic resolution should be national.
- The temporal resolution criterion is set to update of the index by the original source at least every 3-5 years.
- Indicators should also follow the SMART criteria, thus they must be specific, measurable, action-oriented, reliable and time bound.
- Data should be available freely and without cost.
- The methods and the source of data should be transparent without undisclosed transformations or processes.
- The indicators should also be flexible enough to work as individual concepts but also as parts of an index.

Creating criteria for the inclusion of indicators in the index corresponds to one of three points in step 1 adapted from Nardo et al. (2008). Since three gaps were identified in existing risk indices, where the EER Index has the possibility to add new value, efforts were mainly concentrated on finding datasets containing information regarding technological hazards, vulnerability of natural resources and a measure of national capacity to adequately manage the physical environment (Moriniere (b.), 2014). Often the information found were proxies since the best available measurements were aimed to be used and the exact indicators were very often not measured specifically (ibid.). When indicators had been sorted out based on their fulfilment of "most of" the above list of criteria 15 remained (ibid.). Checking the quality of available indicators as well as discussing the strengths and weaknesses of each selected indicator corresponds to step 2 adapted from Nardo et al. (2008). This will be described in the following section.

4.2 EER INDEX INDICATORS

The justification or rationale behind each of the 15 chosen indicators is in short described below, as well as data sources, strengths, weaknesses, potential errors, replacement indicators considered, general metadata, and any required transformations of the data for their inclusion in the EER Index (Moriniere (b.), 2014). Table 3 shows the summarised information about the indicators, followed by comments regarding each indicator following in the subsections below (ibid.). This section corresponds in part to step 2 of constructing an index as described by and adapted from Nardo et al. (2008).

Table 3 Summary of the EER Index indicators according to Moriniere (2014).

Indicator	Number of countries	Data source	Temporal resolution	Spatial resolution	Measuring unit
Hazards					
Industrialisation	47	UNIDO	Annual since 1981, last 2010	Country level	Number
Urbanisation	179	UNDESA	Every 5 years since 1950	Country level	Per cent
Mining & electricity	app. 54	UNIDO	Annual, last 2006 or 2007	Country level	Number
Dams	app. 99	ICOLD	Annual, last 2010	Country level	Number
Rail & road density	app. 113	World Bank	Annual since 2004, last 2011	Country level	Number
Sudden onset natural hazards	191	OCHA/JRC	Annual since 2007, last 2014	Country level	Index number (0-10), InfoRM
Conflict/human hazards	192	OCHA/JRC	Annual since 2007, last 2014	Country level	Index number (0-9), InfoRM
Vulnerability					
Forest	137	EPI	Annual, last 2014	Country level	Index number (0-100), EPI
Water	178	EPI	Annual since 2010, last 2014	Country level	Index number (0-100), EPI
Soils	132 non-European countries	GLADIS	Not annual, dataset dated to 2010(?)	Country level	Index number (XX-XX), LDI/GLADIS
Air	178	EPI	Annual since 2010, last 2014	Country level	Index number, EPI
Biodiversity	178	EPI	Annual since 2010, last 2014	Country level	Index number (0-100), EPI
Human, population density	189	World Bank	Annual since 1961, last 2011	Country level	People/km²
Vulnerability	191	OCHA/JRC	Annual (every 6 months) since 2007, last 2014	Country level	Index number (0-10), InfoRM
Capacity					
Capacity	191	OCHA/JRC	Annual since 2007, last 2014	Country level	Index number (0-10), InfoRM

4.2.1 HAZARDS

The following indicators of hazards, both technological and sudden onset, are highlighted in the EER Index.

INDUSTRIALISATION

The industrialisation indicator is a proxy indicator for hazards and measures the number of employees in the industrial sector (Moriniere (c.), 2014). The indicator is based on the notion that the exposure to industrial accidents increases with the number of employees in the industrial sector, which is in turn motivated by the ARIA database from France (ibid.). This database indicates that nearly 50% of all recorded accidents in 2009 were in the manufacturing sector (Bureau d Analyse des Risques et Pollutions Industriels, 2010, p. 6). The number of employed include the following 23 manufacturing professions (UNIDO, n.d):

- Food and beverages,
- Tobacco products,
- Textiles,
- Wearing apparel, fur,
- Leather, leather products and footwear,
- Wood products-excl. furniture,
- Paper and paper products,
- Printing and publishing,
- Coke, refined petroleum products, nuclear fuel,
- Chemicals and chemical products,
- Rubber and plastics products,
- Non-metallic mineral products,
- Basic metals,
- Fabricated metal products,
- Machinery and equipment,
- Office, accounting and computing machinery,
- Electrical machinery and apparatus,
- Radio, television and communication equipment,
- Medical, precision and optical instruments,
- Motor vehicles, trailers, semi-trailers,
- Other transport equipment,
- Furniture; manufacturing,
- Recycling

URBANISATION[3]

Urbanisation is measured as an annual change percentage of urban population in the country (Moriniere (c.), 2014). The motivation for urbanisation as a proxy indicator of hazards is the belief that with increasing urbanisation one also has increasing industrial risks that will also be more concentrated (ibid.). The change percentage in urbanisation is also considered to be a proxy for vulnerability in the form of densely populated people exposed to the hazard, but this indicator is only included once under the hazard category (ibid.).

[3] Note that this indicator has been altered so as to not include negative values, in the latest version of the EER Index.

MINING & ELECTRICITY

This indicator considers the number of employees within the sector of mining and utilities which includes mining and quarrying, electricity, gas and water supply (Moriniere (c.), 2014). The data has been calculated manually from the UNIDO document entitled (ibid.) “World statistics on Mining and utilities 2010, part 2, Country tables” (Statistics Unit, UNIDO, 2010, pp. 16-137). The rationale behind the indicator is the belief that as mining and utilities increase, so will the risk of industrial accidents (Moriniere (c.), 2014). Also the added value of mining and utility industries remains to 41.3% in industrialised countries while most of the processing occurs in developing countries (ibid.). According to the ARIA database from France the collected information on accidents around the world reveals that 18 out of the reported 913 accidents were connected to the mining sector. This represents about 2% of the total (ibid.).

DAMS

The dam indicator measures the number of qualifying dams (structural dam height above foundation not less than 15 meters) (Moriniere (c.), 2014). The incentives to choose dams as an indicator for environmental emergency risk is that the exposure to dam related accidents is assumed to increase with the number of dams (ibid.). Dams here include hydropower, water supply, flood control, irrigation, navigation recreation, fish breeding, other and in some cases also tailing dams (ibid.).

RAIL & ROAD DENSITY

The indicator shows the sum of railway and roads divided by 100 km 2 land area and is used as a proxy for the amount of transport of dangerous goods (TDG) (Moriniere (c.), 2014). The assumption is that with more railways and roads the transport of dangerous goods and exposure to accidents is also likely to increase (ibid.).

SUDDEN ONSET NATURAL HAZARDS

This indicator is based on information from InfoRM and portrays exposure to the sudden onset hazards earthquakes, tsunamis, floods and storms (Moriniere (c.), 2014). The interpretation is that a higher index number of a country indicates a higher risk of sudden onset natural hazards (ibid.). The exposure is based on former recorded incidence and not on the probability of future exposure and does not include any other than the four natural hazards mentioned above (ibid.).

CONFLICT/HUMAN HAZARDS

The Conflict/human hazards indicator of the EER Index measures exposure to human hazards and conflict through violence intensity, killings and regime stability (Moriniere (c.), 2014). In the EER Index it is believed that with increasing risk of human hazards and conflict the risk of environmental emergencies also increases (ibid.).

4.2.2 VULNERABILITY

The following indicators of vulnerability, both of natural resources and of human beings, are highlighted in the EER Index.

FOREST

Forest cover is important for ecosystems and habitat protection and decreasing forest cover therefore comes with negative implications for these factors (Moriniere (c.), 2014). This indicator measures the change percentage of forest cover between years 2000 and 2012 in areas with more than 50% tree cover (ibid.). Factors that are considered are deforestation, reforestation and afforestation where bare or cultivated land is converted into forest (ibid.). This is also a proximity-to-target indicator meaning there is a set goal level that all performances are measured against (ibid.). The goal for each country is 0 in forest cover change, this renders an index number of 100 (ibid.). As the index increases the country gets closer to the target and the risk for forests decreases (ibid.).

WATER

This indicator includes two parameters, access to drinking water and access to sanitation (Moriniere (c.), 2014). Access to drinking water is measured as the part of the population with access to an improved source of drinking water as main source (ibid.). This is defined as a source that protects the water from outside contamination, particularly faecal contamination (ibid.). Access to sanitation measures the part of the population that has access to an improved source of sanitation, which means that the facility hygienically separates human faeces from humans and is not public, thus it can be private or shared (ibid.). This indicator too is measured as proximity to target, an as the index number increases the country moves closer to the target and the vulnerability of water resources decreases (ibid.).

Access to drinking water is the best currently available proxy for access to clean drinking water (Yale University (b.), n.d.). Both parameters are vital for improving health and wellbeing through reducing exposure to pollution and contamination but are also important for reducing environmental threats as a consequence of improper waste management (ibid.).

SOILS

This indicator measures soil quality with respect to poverty and population, as drivers for land degradation (Moriniere (c.), 2014). High index numbers represent increasing land degradation (ibid.).

The rationale for the indicator is that in areas where the population is poor and/or highly dependent on soil or other natural resources for livelihoods (ibid.), they are also more vulnerable to environmental emergencies according to interviewees. Also the cost and the difficulty of implementing remedial actions is much higher in these areas, adding to the fact that the threat of food insufficiency and income insecurity is also much higher (Moriniere (c.), 2014). The index number accounts for the fact that land degradation has different effects on industrial relatively rich countries than it does on poor rural societies by weighting it according to number of the population concerned and the poverty level in the country (ibid.).

AIR

This indicator is based on the EPI and includes three parameters Air Pollution - Average Exposure to PM2.5 (fine particulate matter); PM2.5 Exceedance; and Household Air Quality - Indoor Solid Fuel Usage for which status is measured once again as proximity to target (Moriniere (c.), 2014). Target levels are set to 10 µg/m3 for Average Exposure to PM2.5 (fine particulate matter); 0% for PM2.5 Exceedance; 0% for Household Air Quality - Indoor Solid Fuel Usage (Yale University (c.), n.d.). With higher index number countries are closer to the target and the fragility of ecosystems and humans to air pollution decreases (Moriniere (c.), 2014). The rationale behind the indicator is that these small particles cause or contribute to several kinds of diseases, respiratory infections and premature deaths (ibid.). Data is collected by satellites which provide consistent and complete values using the same methods and technology for every country (Yale University (c.), n.d.). This gives national indicators for population exposure for all countries on the globe (ibid.).

BIODIVERSITY

This EPI indicator includes four parameters: Critical Habitat Protection, Terrestrial Protected Areas (National Biome Weight), Terrestrial Protected Areas (Global Biome Weight), and Marine Protected Areas, or more specifically the per cent of sites identified by the Alliance for Zero Extinction (AZE) that have partial or complete protection, the percentage of biomes under protected status, and the percentage of country's exclusive economic zone (EEZ) that is under protection respectively (Moriniere (c.), 2014). This indicator is also measured as proximity to target, where high index numbers here indicate that the country is closer to the target and the risk is lower (ibid.). Habitat protection is important to preserve ecosystems and biodiversity critical for sustaining human life and livelihoods but does not suffice in itself (Yale University (d.), n.d). The target levels of the included parameters are set to protect the Earths biological diversity and promote the sustainable use of natural resources and equal sharing of benefits from ecosystems services (ibid.).

HUMAN, POPULATION DENSITY

The indicator measures the total population divided by total land mass as an indicator of vulnerability in terms of number of exposed human beings (Moriniere (c.), 2014). With increasing population density more people are exposed and vulnerable (ibid.). Higher index number indicates higher risk (ibid.).

VULNERABILITY

This indicator is extracted directly from the InfoRM index without alterations (Moriniere (c.), 2014). It is weighted together from two parameters, namely socioeconomic vulnerability which is compiled from the Aid Dependency Index, the Trade Index, the Economical Dependency Index, the Development Poverty Index and the Inequality Index, and the parameter Vulnerable Groups consisting of the Food Insecurity Index, the U5 Index, the HIV, TBC, Malaria Prevalence Index, the Recent Shocks Index and the Uprooted Index (ibid.). Higher number in the index score means higher risk of vulnerability, so as the index number increases, so does the vulnerability (ibid.).

4.2.3 CAPACITY

The following indicator of capacity is included in the EER Index. The environmental performance index as a total index number and the corruptions perceptions index were also considered as indicators for capacity but were later excluded due to too strong correlations with the existing capacity indicator and other indicators.

CAPACITY

This indicator is directly gathered from the InfoRM index without any alterations (Moriniere (c.), 2014). The indicator is calculated from two components which are in turn compiled from a number of indices (ibid.). The one component is called Institutional Capacity derived from the Disaster Risk Reduction Index and the Governance Index, the other component is Infrastructural Capacity consisting of the Communication Index, the Access to Health Care Index and the Physical Infrastructure Index (ibid.). With higher number in the index the capacity decreases (ibid.).

4.3 EER INDEX ANALYSIS

When indicators had been identified at country level the composition for the EER Index was conducted in the following steps:

- Pre-processing

- Inversion
- Skew transformation
- Scale transformation
- Weighting
- Aggregation

These steps roughly correspond to steps 3-6 as adapted from Nardo et al. (2008). Further details will be given below.

4.3.1 PRE-PROCESSING

Firstly, the coverage of the countries' data was examined (Moriniere (b.), 2014). Countries that did not have data for at least three out of five Industrial Hazards indicators, two out of two Non-Industrial Hazards indicators, four out of seven Vulnerability indicators and one Capacity indicator (Moriniere (d.), 2014) were discarded, even if they scored in the top of the index (Moriniere (b.), 2014).

Step 3 from Nardo et al. (2008) covers the issue of imputation of missing data. In the case of the EER Index the technique used is called **case deletion** or **complete case analysis** (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 24). If a dataset has more than 5 % missing values, this method cannot be used (ibid.). For the EER Index, this means that even data missing for one indicator is enough to render this method useless.

4.3.2 SKEW TRANSFORMATION

Some indicators may have values clustered at one end of the distribution instead of around the average value, which is thought to have severe impacts on indices (Moriniere (b.), 2014). In the InfoRM log transformation is used to more clearly differentiate between indicator values in both extreme ends of the distribution (de Groeve, Poljansek, & Vernaccini, 2014, p. 47). Other voices however argue that values should be kept as they are, especially when they reflect the reality in the field (Moriniere (b.), 2014).

In the EER Index all values were log transformed since it could not be decided which indicators should be and which should not on the basis of how large the effect of a small individual increase in each indicator would have on environmental emergency risk (ibid.). The log base 10 was chosen for the EER Index after comparisons against the natural logarithm, the choice of which logarithm is however not critical in most cases (Zumel & Mount, 2013). The skew transformation corresponds to step 5 adapted from Nardo et al. (2008), see section 3.2.5.

4.3.3 SCALE TRANSFORMATION

Since the indicators in the EER Index are measured in very varying units and scales, some kind of normalisation is needed in order to make values comparable (Moriniere (c.), 2014). Normalisation of values was made in the same fashion as in the InfoRM, with a Min-Max-normalisation (de Groeve, Poljansek, & Vernaccini, 2014). This method is described in section 3.2.5. The same normalisation method was applied to all 15 indicators. This step corresponds to step 5 adapted from Nardo et al. (2008).

4.3.4 WEIGHTING AND AGGREGATION

The weighting of indicators is an important step, as even no weighting will indicate an implicit equal weighting of indicators and domains. For now the JEU officers and colleagues have determined weights for the different indicators and domains, as there is for now a lack of deliberate attempt to weight the indicators in a scientifically defensible way (Moriniere (b.), 2014). With the aid of input from experts and field staff the quality of the investigation of the index is hoped to increase and thus give somewhat more scientific reason for the chosen weights in the index. The weights in the EER Index are 40% Hazards, 30% Vulnerability and 30% Capacity, with non-equal, individually chosen weights assigned to each indicator under those three domains (Moriniere (b.), 2014). This is not the same weighting as in the InfoRM (de Groeve, Poljansek, & Vernaccini, 2014), the reason for this is to put a greater weight on industrial hazards where the JEU has a clear mandate. This step corresponds to step 6 adapted from Nardo et al. (2008).

The EER Index has been aggregated through geometric aggregation (Moriniere (b.), 2014). This step also corresponds to step 6 adapted from Nardo et al. (2008).

4.4 EER INDEX STEPS AHEAD

As more data become available, both the InfoRM and subsequently the EER Index is thought to improve over time (Moriniere (b.), 2014; de Groeve, Poljansek, & Vernaccini, 2014). For further improvement the following additional indicators have been considered in future updated versions of the index (Moriniere (b.), 2014):

- For hazards:
  - Nuclear power
  - Industrial sites (infrastructure, mining)
  - Multiple Mortality Risk Index (MRI) based on hydro-meteorological hazards (tropical cyclones, floods and landslides) (UNEG-DEWA-GRID)
- For vulnerability:
  - River length
  - Coastline, length divided by total area or population
- For Capacity:

- "Existence of environment Ministry - Y/N" or "Existence of environmental framework law - Y/N".

5. RESULTS

11 interviews were conducted during this study in order to capture the perceptions of experts and people working in the field and to investigate if these perceptions fit the rankings provided by the EER Index. The organisations interviewed consisted of JEU, CADRI, UNDP Regional Bureau for Europe and the Commonwealth of Independent States (UNDP RBEC), UNEP Regional Office for Europe (UNEP ROE) and the three regional OCHA offices of ROAP, ROCCA and ROSA. For ROAP and ROSA, only one representative was interviewed, while in ROCCA three representatives from OCHA ROCCA, UNDP RBEC and UNEP ROE were interviewed. This results in the maximal number of regionally specific responses for ROAP being seven, for ROCCA nine and for ROSA seven. In the general questions the maximal number of responses is 11.

Below, the interview answers are categorised under different themes deduced and perceived as most crucial for the result of this thesis. The complete list of the questions can be found in Appendix B and the full interview answers can be found in Appendix G.

5.1 THE DEFINITION OF ENVIRONMENTAL EMERGENCY

The opinions of the interviewees regarding what constitutes an environmental emergency are more or less consistent. An environmental emergency is most often expressed by the interviewees as a sudden onset natural hazard that has a (secondary) effect on people, infrastructure and the environment. The secondary effect could be a natural hazard triggering a technological hazard that in turn triggers the emergency, but the emergency is also location, population and capacity dependent.

According to the interviewees, the level of impact of these incidents is determined and influenced by several factors such as the scale of the incident, the location of the incident and the vulnerability of the people and infrastructure in the particular area. For instance, the impact of an earthquake in Indonesia, a more developed country, can be high because of the infrastructure and population density, at the same time a flood in a rural area in Mozambique can have a high impact due to the lower level of development. A majority of the interviewees expresses that incidents that stand out are the ones where there is a combination of severity and long term impact on the environment after the triggering event has occurred. It is not the hazard and its magnitude in itself that make the difference, but instead how vulnerable the community is where the hazardous event strikes.

There are differences expressed among the interviewees regarding whether an environmental emergency would have to affect people or not. For example, if an oil spill occurs in Siberia, a sparsely populated area, is it an environmental emergency or not? The oil is still present and greatly affects the ecosystems, but not many people will be affected by the event. One interviewee expresses that an environmental emergency is the "interaction between the natural disaster and the manmade infrastructure", meaning that an emergency cannot occur without any of these. Some of the interviewees state that the mandate or the line of work is what limits the people's view of the definition. Since we are here dealing with this issue from a human development point of view, the impact on a community and their livelihoods is what is important, not only the preservation of the environment.

Three out of five interviewees from the regional offices do not regard the OCHA definition of an environmental emergency as being impeccable. It is perceived as to generic, long and broad in its definition. The sudden onset part is considered an issue as the interviewees feel that it is difficult to determine where to draw the line between sudden and slow onset. A hazardous event might not have immediate impact on the environment, human lives and livelihoods, but it could have a long term effect. This long term effect was perceived as being hard to interpret within the definition of an environmental emergency according to the interviewees. The context of the definition is linked to technological and industrial hazards, according to one of the interviewees. The same interviewee felt that environmental issues should be integrated in any kind of emergency instead of being treated as an own entity, since the risk of environmental emergencies is present whenever any kind of disaster occurs. Other interviewees felt that the concept of capacity to respond should also be integrated into the definition since it is currently perceived to be absent. Another aspect of environmental emergencies that came across during the interviews is climate change which is currently considered to be lacking in the definition.

5.1.1 HAZARD

The interviewees mention hazards such as earthquakes, floods, landslides and tsunamis and manmade hazards such as chemicals, transports, fires, conflict, explosions, oil spills and infrastructure failure as being thought to cause environmental emergencies. One interviewee, however, persistently insists that any disaster has the potential to cause environmental emergencies and in order to have efficient disaster risk management; the environment should not be viewed upon as a separate aspect. For tables displaying the response frequency of each hazard, vulnerability and capacity mentioned, see Appendix H.

When asked which hazards the interviewees would prioritise, roughly half of them chose natural hazards and the other half chose industrialisation or industries[4]. The natural hazards are considered important since large scale natural hazards affect many people and the aftermath results in a lot of disaster waste. The process of industrialisation/industries and urbanisation is, according to the interviewees, strongly linked to the occurrence and frequency of environmental emergencies. Rapid urbanisation was mentioned as resulting in cities absorbing industrial areas previously located far outside the city, resulting in relocation of the technological hazards to where people live. For instance, as one interviewee described, there was an explosion in an ammunitions depot in Brazzaville, Congo, a couple of years ago. Today, that depot is located within a community and if that same kind of explosion were to happen today, the consequences might be all the more devastating. One interviewee states that the more developed a country becomes the more the risk of environmental emergencies increases. Interviewees further state that many countries also lack urban planning and safety training which will also increase the risks. Industrial disaster risks are also stated as hard to predict since there is not enough data on how they happen and since they are often smaller in scale. The interviewees feel that the importance of a hazard is dependent on human impact, economic impact and the frequency of the hazard. Thus there is a need for further study on this subject.

[4] Authors' remark: There seems to be confusion regarding the use of the words industrialisation and industries. Some mention industrialisation as a hazard while other's mention industries themselves and their characteristics, their location and poor urban planning as the main hazards related to industries. Essentially, these words are all related to the same kinds of events.

One of the interviewees also states that protracted crises or conflicts have environmental impacts, but are not environmental emergencies per se. For instance, a conflict could lead to mass displacement of people which could lead to an increase of pollution, deforestation, erosion and environmental degradation which would risk further sparks in tensions within a community.

5.1.2 VULNERABILITY & CAPACITY

Vulnerability is a wide concept lacking a commonly accepted definition (Birkmann J. , 2007, p. 21; Barnett, Lambert, & Fry, 2008, pp. 103-104). This is demonstrated in the answers from the interviews, where opinions regarding which are important factors to consider in vulnerability clearly differ. One of the interviewees expressed it as "it depends on how you define vulnerability. Environmental people put exposure into the vulnerability side of the equation. The natural disaster people put exposure on the hazard side."

Many of the answers provided regarding important factors of vulnerability fall under the Capacity domain in the EER Index, which coincides with the common perception among the interviewees that vulnerability is the flip side of capacity and thus that lack of capacity enables vulnerability in the case of an occurring emergency. This is supported by the definitions of the two concepts in InfoRM (de Groeve, Poljansek, & Vernaccini, 2014, p. 16) which is the same concept that the EER Index follows.

Five of the interviewees mention the dependency on the environment for livelihood as significant for vulnerability. For instance, rural or indigenous communities are more dependent than others on the environment which will lead to these being more affected by an environmental emergency. Socioeconomic vulnerabilities mentioned are poverty and/or low income, lack of education, lack of access to public health, lack of access to drinking water, lack of knowledge, information, analytical skills and/or tools in terms of addressing environmental problems and malnourishment. Other vulnerabilities mentioned are poor governance, corruption, level of environmental degradation and poor infrastructure. For two of the interviewees the geographic location and the proximity to hazardous industries were considered vulnerabilities and issues to target when dealing with environmental emergencies. One of the interviewees did not agree on the vulnerabilities expressed in the initial version of the EER Index and thought that they were more receptors of an emergency than actual vulnerabilities. Instead, this interviewee expressed that vulnerabilities are to be viewed as lack of knowledge and capacity to cope and respond. Thus, the most frequently mentioned vulnerabilities are environmental dependency for livelihoods, any socioeconomic vulnerability and geographic location. These relate closest to the indicators Water, Soil and Vulnerability in the EER Index.

The question of prioritisation among vulnerabilities is much debated. Four out of the 11 people interviewed suggest you cannot rank vulnerabilities one over the other since they are all equally important. According to these interviewees, vulnerabilities are linked to human rights and no one can be regarded as more important than the other. Comparing vulnerabilities would be like comparing apples and oranges. When investing, opinions were that one should aspire for an even distribution of the resources. The other group of interviewees pinpointed the most important vulnerabilities as being structural in terms of deteriorated infrastructure, the dependency on the environment for livelihoods, any type of socioeconomic vulnerability such as income, food and drinking water as well as geographic location.

5.2 RANKING OF COUNTRIES

In the OCHA region of Asia and the Pacific, Indonesia, China and India are mentioned by four out of seven interviewees as being the most prone to environmental emergencies. The other interviewees mention one or two of these countries. The top three ranked countries in the EER Index are East Timor, Cambodia and Papua New Guinea[5].

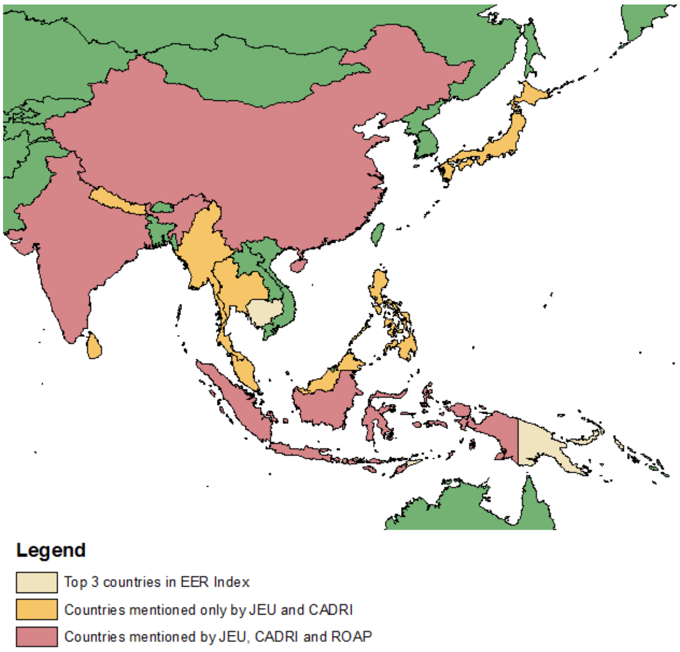

Figure 1 The countries mentioned in the region of ROAP.

China and India are thought by the interviewees to possess good governance capacities, but they are at the same time dealing with rapid industrialisation and urbanisation processes coupled with large populations and with their countries being situated in an area prone to natural hazards. In Indonesia and India, a large part of the population is also living on the margins of poverty.

In the OCHA region of Caucasus and Central Asia eight out of nine interviewed mention Tajikistan and four of out of nine mention Kyrgyzstan as countries prone to environmental emergencies. Armenia, Georgia and Kazakhstan are mentioned by three interviewees and two out of the three interviewees from the regional offices mention Fergana Valley, Turkmenistan and Uzbekistan. Mongolia, Moldova, Afghanistan and Pakistan are each mentioned by one interviewee. The top three ranked countries in the EER Index are Tajikistan, Azerbaijan and Kyrgyzstan[6].

[5] Note that in the latest version of the EER Index the three top ranked countries in ROAP are India, Papua New Guinea and Cambodia.
[6] The ranking in ROCCA has not changed after the latest modifications of the EER Index.

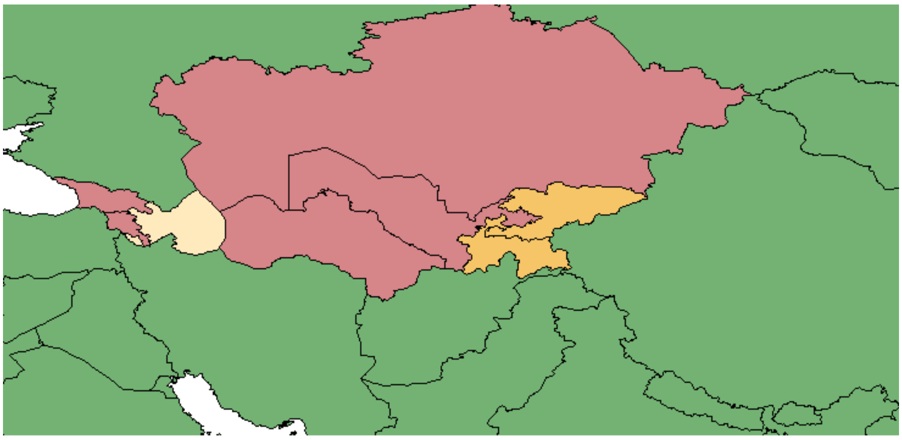

Figure 2 The countries mentioned in ROCCA.

In Tajikistan and Kyrgyzstan there are a lot of industrial legacy sites, poverty and the countries' capacities to cope are low according to the interviewees. The regional offices are more focused on the Fergana Valley than trying to pinpoint countries. The Fergana Valley is located partly in Uzbekistan, Kyrgyzstan and Tajikistan. It is a very densely populated area with a lot of different ethnicities and because it is a border area there are issues with border demarcation and conflicts over land ownership according to the interviewees. Interviewees further state that in this area water sources are scarce, there are energy conflicts, and it is also a natural hazard prone area frequently struck by earthquakes, floods and mudflows which combined with the unsafe uranium and pesticides storage sites makes it a top priority area.

In the region of Southern Africa, six out of seven interviewees mention Madagascar while four out of seven mention Mozambique. Angola is mentioned by two of the interviewees and South Africa, the Seychelles and Malawi are each mentioned by one interviewee. The top three ranked countries in the EER Index are Mozambique, Angola and Zimbabwe[7].

[7] Note that in the latest version of the EER Index the three top countries in ROSA are Mozambique, Tanzania and Zimbabwe.

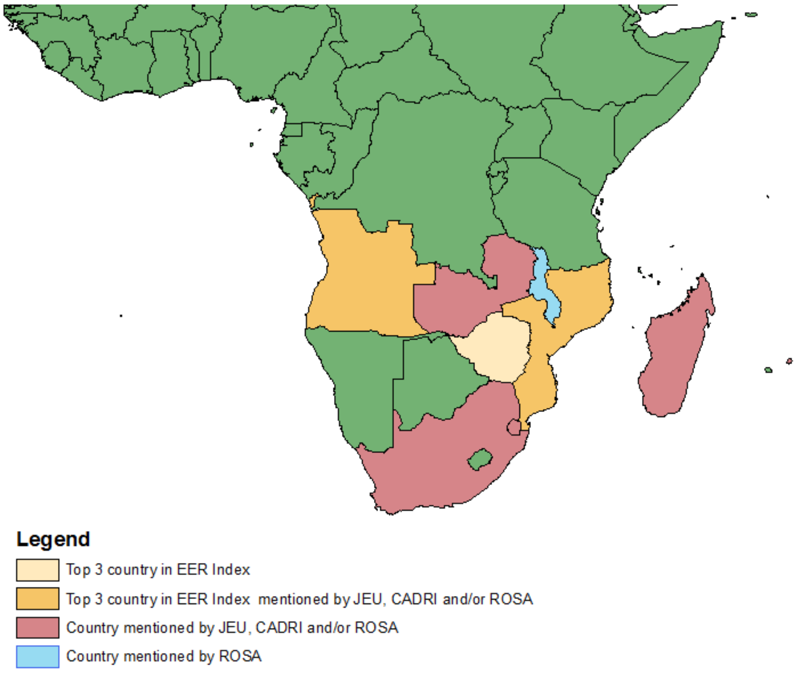

Figure 3 The countries mentioned in ROSA.

The interviewees state that, in this region, the development process of industries in combination with bad governance and low capacities to cope is what make the countries prone to environmental emergencies. In Madagascar there are also a lot of mining industries while in Mozambique and Angola oil and gas exploration are dominating and these are factors of importance. Madagascar and Mozambique are additionally frequently affected by cyclones.

5.3 USEFULNESS OF EER INDEX

With this index, it is thought by the interviewees from JEU that attention will be focused on addressing environmental emergencies and on emphasising the role of the environment in disaster response. The index will aid in identifying the countries that are most at risk and thus also indicate where to focus resources in terms of for example capacity development, staff and funding. It is also possible to break the index down in its components to know what sort of capacity building is needed in the country or region. Further, the interviewees state that the credibility of funding will increase and this will positively affect donors and the rest of the humanitarian community. The index is also believed to make the organisation more cost-effective since resources will be invested where the highest return is achieved.

Other interviewees express that the index will most likely be an additional aid for decision making since yet another aspect will be taken into consideration. It is thought that it will be a quicker and easier way to communicate with people unfamiliar with this sector and it might enable a more realistic placement of resources. Since the index is thought to be more scientifically valid according to one of the interviewees, it will be used for developing an own specific version with regionally applicable indicators and with regional data.

A food for thought regarding the launching of an index is how the reception of the EER Index from the countries will be. One of the interviewees states that *”we like to rank others but we do not like to rank ourselves”* and stresses the importance of carefulness in terms of what the tool can and cannot do and what the impact of it will be.

5.3.1 DATA COLLECTION AND QUALITY

The interviewee from ROAP states that there are national data sets available that could be of use for the EER Index. To be able to collect these data one would have to have a meeting with the national statistical offices (NSO) and explain why the data is needed and what it is going to be used for. Some governments can then see the added value of providing the data, while others cannot. The subject of collecting data for environmental risk is, however, a completely different story since these kinds of data is often very politically tied.

The OCHA ROCCA interviewee states that it is not easy to collect direct information from governments because they are not always willing to share their information. Instead, OCHA ROCCA works with different UN agencies and other organisations to do their own data collection. The major problem with this is that it is time consuming and also impossible to collect data for all countries in the region and for all datasets. The interviewee from UNDP RBEC agrees on the problem with unwillingness of governments to provide data and adds that the data that exists is not always the data that you want and not useful for what you are trying to measure. The UNEP ROE interviewee agrees with this and further states that this is for example illustrated in archives being manually handled on purpose and that technology such as satellite imagery could help in mapping where industrial sites are located, but the issue on knowing what they contain however persists.

In ROSA there are national databases in most of the countries but the quality and size of them varies since they are newly established, according to the interviewee. The availability of data is connected to the sovereignty of states and the specific access to hazard data is limited since all countries do not measure all kinds of hazards. Information on hazards such as military locations or location of industries, nuclear facilities and weapon storages is not something that most countries are willing to share.

6. DISCUSSION

In this section the general findings and summarised thoughts of the literature study on indices, the results from interviews and the examination of the first version of the EER Index are presented. In areas where it is possible with regard to the scope of this thesis, suggestions for alterations or possible improvements of the current index are made, in others perceived issues or problematic assumptions are merely highlighted for the reflection of future revisers of the EER Index.

6.1 RECENT ALTERATIONS IN THE EER INDEX

Since the proposed changes of the thesis, some alterations in the EER Index have been made. These alterations have affected both the rankings and the methodology.

6.2 INDEX

The advantages and disadvantages of using indices as measures of the complex reality is a widely discussed subject that probably will never reach consensus, since people wish to obtain different information from the indices (ten Brink, 2006, p. 4; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 14). Stakeholders, politicians, decision makers and policymakers want to obtain a broader view of the situation such as the key message expressed in numbers (ibid.). The scientists and statisticians, au contraire, are more concerned with the details, the reliability, the accuracy and the replicability of the data sets (ibid.). Therefore, scientists and statisticians tend to resent indices, where a lot of data and the work on data collection are not visible, while stakeholders and other decision makers enjoy the simple summary of complex processes (ibid.).

There will always be uncertainties in data and an entirely perfect solution is not possible to achieve (ten Brink, 2006, p. 5). This could produce an index that is not properly fitted for what it is trying to measure and which will therefore never fully be accepted by its target audience (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 14). Below the information pyramid is shown, as adapted from ten Brink (2006). It illustrates how the level of aggregation is dependent on the needs of the intended user:

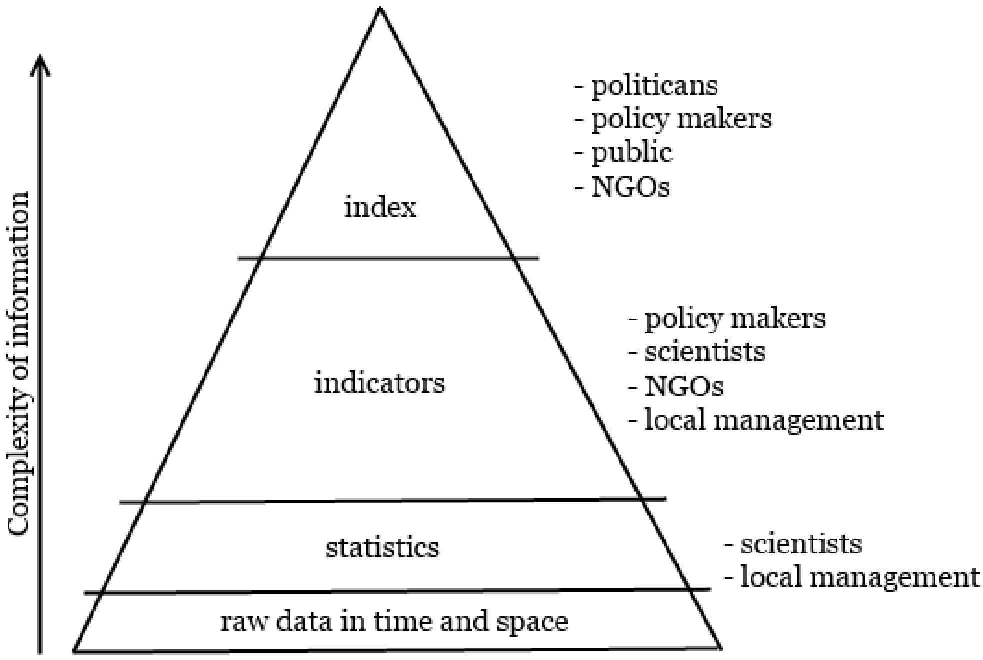

Figure 4 The information pyramid adapted from ten Brink (2006).

This illustrates the problem with the scientists and decision makers not speaking the same language and thus not understanding each other since many concepts are not well or commonly defined (ten Brink, 2006, p. 5). The complexity of the data depends on the user needs and thus scientists could be more interested in looking at the raw data, i.e. the measurements from the field, while decision makers want to see a wider picture in order to perform their work (ibid.). The problem with communication has resulted in the management of disasters after an event has occurred, instead of looking at trends and preventing and preparing for them (ibid.). This can be seen, for instance, in the emission regulations that have been adopted after lethal poisoning has occurred (ibid.). By developing the EER Index, the problem with communication between scientist and decision makers might be partly overbridged since the index will analyse trends and make preparedness more efficient. In the long run, this could lead to human lives and livelihoods being spared or less affected by disasters. This emphasizes the importance of transparency in the methodology and data used for the EER Index, in order to gain ground on as many levels as possible, both in the scientific arena and in policy- and decision making.

6.3 EER INDEX

The EER Index is made up by 15 indicators, where seven belong to hazards; seven to vulnerability and one belongs to the domain of capacity. The EER Index strives to align with and thus have much the same methodology as the InfoRM, see Appendix A. What has been noticed is however that in some indicators data has been found for countries which are not included in the InfoRM. These countries have not been included in the EER Index, which is however not believed to be a problem since the EER Index criteria for countries include that data is available for at least three out of five indicators for industrial hazards, two out of two indicators for non-industrial hazards, four out of seven vulnerability indicators and one capacity indicator. These additional countries or states that are not in the InfoRM are likely to have been excluded from the ranking due to not meeting these criteria, which is why this is not likely to pose an issue.

6.3.1 CHOICE OF INDICATORS

In this section the discussion concerns general possible limitations and challenges in each of the indicators, largely following the concerns highlighted by the JEU themselves in the working process, along with specific issues or concerns that have been identified, with suggestions for steps forward presented where possible.

In order to construct a meaningful EER Index as defined by Pelling (2004) and Kaly, Briguglio, McLeod, Schmall, Pratt & Pal (1999) there should be a strive to upgrade proxy indicators into indicators that measure the actual objective. The scope of investigation for the EER Index should thus be broadened by searching for more input to the relationships between current and potential additional indicators, and environmental emergencies in order to find the drivers for the environmental emergency risk. When these have been identified in consensus it can be assumed that the index is meaningful in the sense of measuring its objective. Thereafter one should strive for transparency and comprehensibility of the index to maximise its usability and enhance the possibility of external agents to provide input for improvement of the index. This will likely facilitate more global spread and integration of the index into general codes of conduct for a broader variety of organisations.

The number of indicators in an index contributes both to model accuracy and complexity but also influences the size of the total error due to bias and variance (Fortmann-Roe, 2012). Too few indicators will increase the risk of bias giving errors in the result while too many indicators will increase the risk of variance giving errors in the result (ibid.). To gain a more accurate view of the local situations more indicators may be recommended in the EER Index, but as this will also increase the model complexity and the variance of the results it will contribute more to the total error of the results. To achieve a more globally applicable index fewer indicators may however be advocated. In order to minimise the total error one should strive for an optimal number of indicators neither overly affected by bias nor by variance, see illustration below.

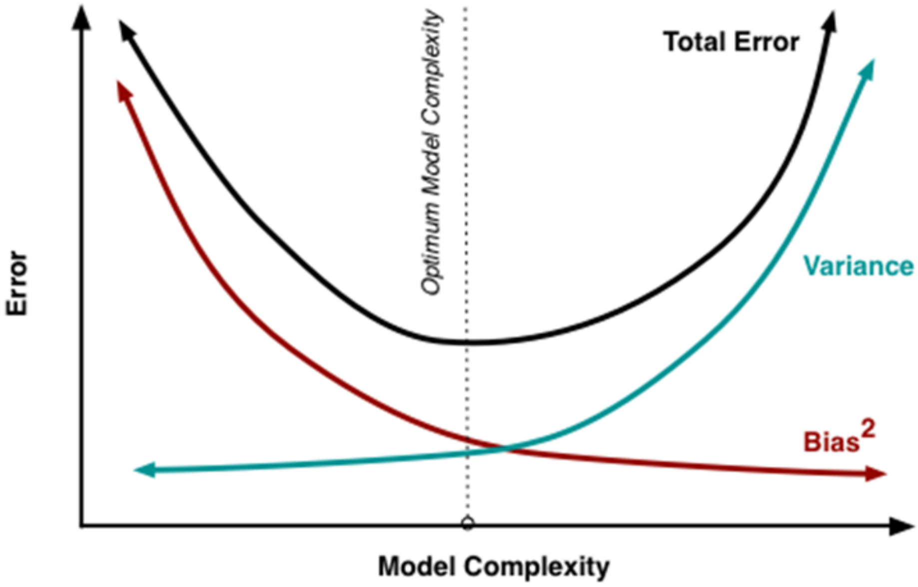

Figure 5 Illustration of how much bias and variance contribute to the total error, according to Fortmann-Roe (2012).

GENERAL LIMITATIONS AND POSSIBLE ERRORS

In this subsection possible errors and limitations in each indicator are highlighted, other indicators that have been considered are also presented.

HAZARDS

The indicators described below are related to the hazard domain in the EER Index.

Industrialisation

The industrialisation indicator measures the number of employees in the industrial sector. The biggest problem with this indicator is the relatively weak global coverage of data with only 47 countries accounted for, and the fact that the previous data update was scheduled for 2012 but has not yet been published (Moriniere (c.), 2014). There is also no knowledge of potential reporting errors or known consideration shown to the fact that the number of people employed is not necessarily the same as the number of people engaged (ibid.).

Other indicators that have been considered include change percentage in number of employees between two years, using the number of establishments instead of the number of employees, using grossed fixed capital, using output, using value added, and investigating the possibilities of finding data from OECD or ILO and also using a planned study of global industrial sites of UNEP/GRID for GAR2015 (ibid.).

However, using the change percentage in number of people employed would introduce the chance of negative values. Negative values are not desirable as they belong to interval scales while indicators with fix zero points belong to ratio scales, aggregating the two will not create a meaningful environmental emergency risk index (Ebert & Welsch, 2004). Also, the number of establishments might be a relevant choice although that depends on what effects are being studied. With larger establishments, an increased risk of accidents might be expected but the consequences of an accident are also dependent on both the materials handled in the industry and the safety culture in the business. If however the effect one wishes to measure is connected to the number of people made unemployed or injured in an accident, then the number of employed might be a better measure. The question is much related to what affects one aims to measure.

Another remark regarding the industrialisation indicator is that it considers the number of employees within the industrial sector in each country, with China naturally topping the list with 83 million and Liechtenstein ending up in the bottom with only 11065 employees. Reflecting upon this it seems that the indicator reflects neither the size of the country at hand, nor the size of the population. The consequences of using the number of employees as an absolute number is that the results will favour more populated countries, while if inversely considering the number of employees in the industrial sector relative to the population size in total will reverse the problem and favour less populated countries with high density of industries (de Groeve, Poljansek, & Vernaccini, 2014, p. 28). In the InfoRM, when this problem arose for population exposed to natural hazards it was accounted for by calculating the number of exposed people both ways and the aggregating the results using an arithmetic average (ibid.). It could be a suggestion to try this approach also in the EER Index.

Another suggestion in this case is describing the industrialisation indicator, and consequently the risk from industrial establishments, in terms of the density of industrial facilities in a specific country, but also in relation to the density of the population in the near surroundings of such facilities. This is believed to reflect in larger extent both the risk of an industrial accident and also magnitude of the threat of harm to human health and/or livelihoods as well as environmental damage. One proposed improvement is to relate the number of employees within the industrial sector to the population size and the population density, see equation 1 below.

$$Industrialisation = \frac{employees\ industrial}{population\ size} \times \frac{population\ size}{land\ areal} = \frac{employees\ industrial}{km^2} \qquad \text{Equation 1}$$

Urbanisation

The urbanisation indicator is measured by the change percentage of the total population living in urban areas between two years. Possible sources of error in this indicator include the fact that information is produced nationally and based on definitions and criteria established by national authorities (Moriniere (c.), 2014).

Other indicators that have been considered include change percentage of urban areas and percentage urban area a given year (ibid.). Using instead the absolute percentage of urban area a given year would make all current indicators in the EER Index ratio scale and thus facilitate more motivated aggregation and improve chances of creating a meaningful index as defined by Ebert & Welsch (2004). Ratio scale indicators are generally more flexible to aggregate in a meaningful way, which is why this scale is more preferable to use (Böhringer & Jochem, 2007, p. 3). Using the change percentage of urban area would show how fast cities were growing which might indicate where weak urban planning might cause increased risks of industrial accidents. When industries, which were previously located in the outskirts of cities, suddenly end up right near the city centre their impact on the surroundings in the event of an accident will be much larger than before. However, using a change percentage will possibly introduce negative values into the index, the potential effects of which will be discussed below.

Most indicators in the EER Index are measured in a ratio scale, meaning that there is a fix zero point (Ebert & Welsch, 2004), except for the indicator Urbanisation[8] which is measured as an annual change percentage of urban population in the country. As this indicator can result in negative numbers it belongs to an interval scale and can thus not be aggregated with ratio scale indicators to produce a meaningful index (Ebert & Welsch, 2004). The reason for why different scales cause ambiguities in aggregation is that the choice of aggregation method may influence the ranking of the results (ibid.). For the index to be meaningful the rankings must remain constant regardless of aggregation method, or else only one of the aggregation methods available is valid (ibid.).

All countries for which urbanisation assumes negative values, thus where there is a decrease in that particular hazard and consequently a decreased contribution to the overall risk of environmental emergencies, are currently raised to the value of 0,1%[9] (Moriniere (d.), 2014). This would result in an exaggerated risk for countries where urbanisation is in fact decreasing and should render them a lowered risk. Perhaps a 0,1% increase in urbanisation is a low enough value not to introduce issues in the interpretation of the results, but it does nonetheless still introduce an issue of inconsistency in the management of data. Worst case scenarios resulting from this could be for example an altered ranking of the risks for certain countries, shifting priorities from those in most need to those not experiencing as high a risk, which is counteracting the aim of the EER Index. An alternative method proposed by Box & Cox (1964) and Buthmann (2010) is to add the same constant to all values. The constant would be decided by determining how much the lowest and thus most negative value needs to be raised in order to attain a positive value, and then this constant will be added to all consequent data for that indicator. This will not change the intrinsic relationships between the data (Osborne, 2010) and might thus improve consistency in the management of data.

The reason for this raising of negative values into an increase of 0,1% is believed to be due to the log transformation that is performed for all indicator values to account for possible positive skewedness; such log transformation is not possible for negative values. However, there is no clear justification for transforming values to account for skewedness, either following the natural logarithm or the common logarithm (Alkire & Foster, 2010, p. 15). The InfoRM motivates log transformation where there is positive skewedness of data by concluding that:

"The log scale gives more weight to the differences between the countries with lower values and less weight to the countries with higher values of indicator. Log transformations take into account not only the absolute difference between two countries similar in performance but also the proportion of the gap compared to the real value of the indicator. The same gap on the lower side of the range is more important than being on the upper side of the rank. Therefore transformed data more clearly differentiate the small differences at all ranges of

[8] Note that this has changed in the latest version of the EER Index.
[9] Note that this has changed in the latest version of the EER Index.

performance and improve the interpretation of differences between the countries on opposite ends of ranking." (de Groeve, Poljansek, & Vernaccini, 2014, p. 47)

Where it is justified to change the absolute differences between countries, the InfoRM uses either this log transformation or square transformation (de Groeve, Poljansek, & Vernaccini, 2014), however this is not done for all indicators but only nine out of the total fifty in the InfoRM (de Groeve, Poljansek, & Vernaccini, 2014, pp. A3-A104).

In the EER Index it is however suggested that:

"Because there was no defensible way to choose some of the 17[10] *indicators to log and not others, the full set of 17 was logged. The same rationale (described above) that supported logging some indicators was assumed to also improve the others (or at the very least, not to serve as a detriment). Both HDI and InfoRM also apply log transformations in their database for some, if not all variables."* (Moriniere (b.), 2014)

As perceived from the InfoRM methodology not all values are log transformed, but only those in which there is a positive skewedness. Looking at the tests for skewedness in the EER Index indicators it is perceived visually clear which indicators are suitable for log transformation and which are not. An alternative to log transforming all values is thus to only apply this for the indicator data that are in fact positively skewed. For negative skewedness there are other procedures to use in order to manage the data, see further in Box & Cox (1964) and Buthmann (2010).

It is primarily suggested that the urbanisation indicator be changed into a measure that assumes only positive values, as this indicator is showing positive skewedness in test and thus might need log transformation. This is to facilitate a simplified and more easily defensible aggregation of indicator values into a meaningful index of Environmental Emergency Risk (Ebert & Welsch, 2004).

Mining & electricity

This indicator measures the number of employees within the sector of mining and utilities. Limitations in the mining and electricity indicator include the fact that there is no actual database but values have been calculated by hand from the UNIDO document (Moriniere (c.), 2014). Important to note is however that any errors in the data handed in by each country will be directly transferred into this indicator (ibid.). For some countries in the UNIDO report, the number of employees in different sectors have not been summarised, the reason for this is not clear, and although sometimes the sums did not make out the sum of the individual entries, they were used as the total number of employees in the EER Index (ibid.). The variation in handed in information varies between countries, and some do not report number of employees but instead number of people engaged, some report output and establishment and yet others report mining but not utilities data (ibid.). The data has reportedly been retrieved from the ARIA database from France. The collected information on accidents around the world reveals that 18 out of the reported 913 accidents were connected to the mining sector. This represents about 2% of the total (ibid.). This number has not been possible to verify by the authors of this thesis and thus maybe more transparency in data sources could be advocated for.

[10] Note that this refers to the version of the EER Index when there were three indicators for Capacity.

Other indicators that have been considered include number of establishments, grossed fixed capital, output and value added ad well as considering merging this indicator with the industrialisation indicator mentioned above (ibid.). Much of the same reasoning as for the industrialisation indicator is also true here, the number of establishments might reflect an additional dimension of the risk of accidents with consequences for environment and livelihoods. If one holds the assumption of the risk for accidents being equal regardless of the size of the establishment to be true, then an increased number of establishments will render the country a larger risk. If however one believes the size of the establishment is a more determining factor for the size of the risk, then the number of employees might be a better measurement of the risk. One suggestion in the latter case could be to divide the industries into groups where industries exceeding a certain number of employees are counted but smaller industries are not included because their risk is considered small enough not to contribute much to the grand total.

Concerning industrial accidents it is harder to collect data since the consequences and accidents are usually more small scale than disasters stemming from natural hazards, according to interviewees. The effects are also on a more local scale, which poses the question of how narrow the perspective of environmental emergencies should be, how many people should be affected in order for it "to count" as an emergency? Where do you draw the line?

Dams

The dam indicator measures the number of qualifying dams (structural dam height above foundation not less than 15 meters) (Moriniere (c.), 2014). Possible errors and limitations in this indicator, where the number of dams are presented, include lack of data, and the fact that calculations have been made on basis of data that are provided and have otherwise been ignored (ibid.).

Other indicators that have been considered as environmental emergency risk indicators for dams are number of dams exceeding a certain age, number of dams greater than a certain size, number of dams of a certain type that more often have accidents as well as the World Register of Dams from CIGB ICOLD which is available for purchase and contains more than 50 000 dams (ibid.). As the incentives for the indicator states that the number of accidents related to dams are believed to increase with the number of dams, this seems like a wise choice of indicator. If however one would consider the number of accidents increasing with the size of the dam, or the age of the construction or even that accidents are more frequent in a certain type of dam, then another choice of indicator might be more motivated. Studying statistics regarding dam related accidents would probably show which of the above factors is the most determining for the size of the risk.

Rail & road density

This indicator measures the sum of railway and roads divided by 100 km^2 land area (Moriniere (c.), 2014) as a proxy for transport of hazardous goods (TDG). One of the limitations of this indicator includes the low reporting, where 72 countries have no reported roads or railways (ibid.). Another consideration to bear in mind is the fact that this indicator may exaggerate the risk for small and developed countries (ibid.).

Other indicators that have been considered as proxies for TDG are the World Bank data over goods transported by road by volume in million metric tonnes transported with road vehicles times the distance transported in kilometres. However this indicator was rejected due to low coverage of data (Moriniere (c.), 2014; de Groeve, Poljansek, & Vernaccini, 2014). Other considered indicators include oil spills, container/port traffic, UNECE Intl. Road Traffic Accident Database (IRTAD) and length of coastlines and/or rivers.

One issue perceived, is that road density is included in the InfoRM indicator Lack of coping capacity (in the EER Index called Capacity), which might cause double counting. This might not show in the correlation matrix due to the fact that the *Lack of coping capacity* consists of many sub-indicators as well as the fact that in the EER Index rails have also been added. The source of data is in both cases the World Bank which further implies the risk of double counting (Moriniere (c.), 2014). This indicator might need further evaluation in order to be a suitable proxy for transport of hazardous materials. One suggestion could be to exclude road density from the Lack of coping capacity indicator and through that construct a new alternative for Capacity indicator in the EER Index.

Sudden onset natural hazards

This indicator measures exposure to four sudden onset hazards (Moriniere (c.), 2014). One limitation in this indicator is that the calculated exposure is based on former recorded incidence and not on the probability of future exposure and does not include any other natural hazards than earthquakes, tsunamis, floods and storms (ibid.). Other indicators that have been considered include the UNEP/GRID probability estimates (ibid.). There might be a weakness in this indicator not capturing the effects of climate change, which many interviewees have also mentioned as being an important factor for calculating environmental emergency risk. Trying to capture this effect into the EER Index is believed to strengthen the accuracy and credibility of the index.

Conflict/human hazards

The Conflict/human hazards indicator of the EER Index measures exposure to human hazards and conflict through violence intensity, killings and regime stability (Moriniere (c.), 2014). In the case of this indicator, the same limitation applies as to the previous one, namely that it shows only exposure based on former recorded incidents and not the probability of future events (ibid.). As it takes at best one to two years for "new" information to be updated into the index data the risk is never fully up to date, which is unavoidable due to the administrative challenge in collecting and compilation of information. Thus any index reflects more long term trends and not so much recent fluctuations in risk. As it is hard to predict the risk of conflict or other human related hazards, other indicators worth considering are hard to suggest since we live in a complex and ever changing world.

The indicators described below are related to vulnerability domain in the EER Index.

Forest

Concerning the Forest indicator, measuring the change percentage in forest cover, possible limitations include the "growing stock change" part of the indicator, where there are inconsistencies in measurement due to differences in data collection methods and frequency of assessments (Moriniere (c.), 2014). Generally there is a lack of global scale uniformity in reporting data on this indicator (ibid.). Furthermore, the FAO, who collects this data used by EPI, generally accepts values reported by countries without an independent verification mechanism (Yale University (a.), n.d.). To compensate to some extent for these limitations the 2014 EPI includes also a measure of forest change stemming from satellite data collected over the past two years which largely improves the reported data and which will also hopefully be updated annually in contrast to data from FAO which is updated only every five years (Yale University (a.), n.d.).

Other indicators considered are the SOPAC EVI but this was rejected since it is no longer updated and has no time series for data (Moriniere (c.), 2014).

Water

Water as an indicator in the EER Index is taken from the EPI and measures Access to Drinking Water and Access to Sanitation (Moriniere (c.), 2014). Possible errors or limitations regarding the Water indicator include the lack in data sets concerning the affordability of water and the extent to which water is deemed as safe for consumption (Yale University (b.), n.d.). Additionally the "access to sanitation" parameter does not measure the degree to which water is treated before it is released back into the environment, which is important to be able to determine the potential risks of sewage water polluting fresh water sources and ocean ecosystems and subsequently posing a risk to human health (ibid.). The EPI has introduced a new indicator on wastewater treatment in the Ecosystem Vitality component of the overall 2014 EPI (ibid.).

Other indicators that were considered are the SOPAC EVI but this was rejected since it is no longer updated and has no time series for data (Moriniere (c.), 2014).

To account for at least one of the limitations mentioned above, regarding the degree of water treatment, the newly introduced "water treatment" indicator might be suitable to include in the EER Index as a complement to the overall Water indicator, if this has not already been done. Additionally the indicator is, just like the indicator Road density, in part included in the InfoRM indicator Lack of coping capacity which is used in the EER Index as the indicator for capacity. This can cause double counting and decrease the meaningfulness of the EER Index. It is recommended that the sub-indicator is excluded from the InfoRM indicator before it is integrated into the EER Index or to investigate the possibility of using other indicators to describe the issue of access to drinking water and sanitation.

Soils

The Soil indicator measures soil quality transformed to reflect both inhabitants/population and poverty (Moriniere (c.), 2014). Possible errors and limitations in the indicator include skewedness of data which may require logging of data values (ibid.). Also, as the index is based on calculations of per cent of land divided by the number of the population living in areas with land degradation, large countries will inevitably be scored lower than will smaller countries (ibid.).

Other indicators that have been considered include the EPI agriculture indicator, the Land Degradation Index (LDI), the Biophysical degradation index and the Ecosystems service status index (ibid.).

Air

The Air indicator measures Air Pollution - Average Exposure to PM2.5 (fine particulate matter); PM2.5 Exceedance; and Household Air Quality – Indoor Solid Fuel Usage as indication of air quality (Moriniere (c.), 2014). Other indicators that have been considered are the SOPAC EVI, which was excluded due to lack of time series and updates, and climate change indicators (ibid.). It is however thought that climate change indicators will put more focus on increased severity of hazards and not so much on health effects since climate change entails so much more than this, and thus that such an indicator is more suitable in other dimensions than vulnerability (ibid.).

Biodiversity

Biodiversity as an indicator measures Critical Habitat Protection, Terrestrial Protected Areas (National Biome Weight), Terrestrial Protected Areas (Global Biome Weight), and Marine Protected Areas, or more specifically the per cent of sites identified by the Alliance for Zero Extinction (AZE) that have partial or complete protection, the percentage of biomes under protected status, and the percentage of country's exclusive economic zone (EEZ) that is under protection respectively (Yale University (d.), n.d).

Possible errors or limitations of the biodiversity indicator include for example the exclusion of riverine fisheries and the lack of data for effectiveness of protected area management, also trends in species abundance, enforcement of wildlife trafficking laws, and quality of landscape conservation efforts would be desirable, but sufficient internationally comparative data are not available at this time (Moriniere (c.), 2014; Yale University (d.), n.d).

Human, population density

The indicator measures total population divided by total land area (Moriniere (c.), 2014). No other indicators have been considered for this aspect of vulnerability (ibid.).

One limitation in this indicator might be that the accuracy in the civil registration systems can vary greatly between different countries, where some countries have much greater population size than what is registered either in their national registration systems or the World Bank database and thereby their risk might be underestimated in this particular indicator. There are, despite their clear benefits of civil registration, according to the World Health Organisation (WHO) Global Summit on Civil Registration and Vital Statistics over

100 developing countries around the world who do not having well-functioning civil registration and vital systems (World Health Organization, n.d.). Around one third of the world's annual births, 40 million, are not registered and around two thirds of the annual deaths globally, also 40 million, are either not registered or incorrectly certified (ibid.). This makes data collection and increased awareness important, but also a continuous updating of the EER Index indicators, all the more important. Since also deaths fail to register within most countries' civil registration systems, the reverse situation where the number of inhabitants in the country is overestimated is also plausible. As this would result in an overestimation of the risk, it would however likely gain momentum in any kinds of interventions targeting issues related to environmental emergencies or capacity development, since it forms one of the cornerstones for exposure to risk.

Vulnerability

The Vulnerability indicator is an InfoRM indicator that measures both Socio-Economic vulnerability and Vulnerable Groups (Moriniere (c.), 2014). Possible limitations and errors regarding the vulnerability indicator include the data sources and weighting in the InfoRM (ibid.) as well as the general constraint of timeliness since most data are at least 12 months old when reflected in the index. The consequence of this is that the index reflects more long term trends and historical risks rather than future risks and recent fluctuations in risk (ibid.). There is uncertainty regarding whether or not the InfoRM is so related to the GFM that the limitations follow from the one index to the other, but if that were to be the case, then there is yet another limitation regarding countries where data is missing for a specific year (ibid.). In these cases, in the GFM, the data have been collected from other reputable sources or previous years and then been analysed of that country alongside its peers, in some cases the data has been estimated based on country research, comparisons with similar and neighbouring countries and expert judgement (ibid.).

Other indicators that have been considered include the isolated components of this index (ibid).

If it is correct that the data from GFM have been used for this index, and thus imputation of missing data has been conducted, then there are likely large uncertainties in these values. In the case of missing data in other indicators in the EER Index, countries have been excluded. So if countries with missing values here have not been excluded but instead had data estimated through different imputation methods this will cause inconsistencies in the calculation and management of data in the EER Index. In the InfoRM the following is concluded about imputation of missing values:

"In general, if data for some countries are not available for a given year, the data from the most recent year available is used. For indicators which encounter that problem, a threshold is defined how far back data can be used (ANNEX B). The acceptable span is dependent on the fluctuation and predictability of the indicator. In the case of the missing data due to the weak coverage two approaches are applied. First approach is to introduce more than one indicator for the same component to complement each other. The second approach is the prediction of the missing value based on the estimated relationship with another indicator. For example, Human Development Index plays important role in the Socio-Economic Vulnerability category but data were missing for 2.6% of countries (i.e., Democratic People's Republic of Korea, Marshall Islands, Tuvalu, Nauru). Due to a strong

relationship (Figure 11) of HDI with the GDP (PPP) per capita, missing values were imposed with the predicted value of HDI based on the known GDP (PPP) per capita for specific countries obtained from regression analysis executed on the rest of the set" (de Groeve, Poljansek, & Vernaccini, 2014, pp. 46-47).

This implies that since missing data are handled in a very different manner for the EER Index, there might be inconsistencies in calculation of indicators which may have unforeseen consequences for the results. In the EER Index the method used for missing values is called case deletion or complete case analysis.

CAPACITY

The indicator described below is related to the capacity dimension in the EER Index.

Capacity

Capacity as an indicator in the EER Index measures both Institutional Capacity and Infrastructural Capacity (Moriniere (c.), 2014). Possible limitations in the indicator include the data sources and weighting (ibid.).

Another specific limitation of the indicator is that it might be somewhat collinear with the Rail/Road Density indicator through the Physical Infrastructure Index (ibid.). Overall the same limitations go for this indicator as it does for the other indicators collected from the InfoRM, namely the timeliness of the data meaning that updates reflect events that are at least 12 months back in time and often more which in turn means that the index cannot show future predictions of risk but only trends from the past (ibid.). For this indicator of course also the limitation of unavailable data where estimations have to be made based on alternative reputable sources or data from a previous year is true (ibid.). In some cases even estimates are used where primary data do not exist from a reputable source (ibid.). Estimates are based on country research, comparisons with similar and neighbouring countries and expert judgement (ibid.).

Other indicators considered include the isolated components of this index (ibid.). Much of the same reasoning can be made here as for other indicators stemming from the InfoRM, see previous.

As previously mentioned there is a risk of double counting in this indicator as it might capture some of the same aspects as the Rail & road density indicator and the Water indicator previously discussed. This may cause ambiguities in the calculation of the resulting index and have unforeseen consequences for the subsequent ranking of countries. Suggestions are that these dimensions be further investigated for possible correlations and possibly excluded from the InfoRM Capacity indicator before adopting it into the EER Index.

6.3.2 IMPUTATION OF MISSING DATA

As discussed in section 3.2.3 regarding imputation of missing data, the following observations have been made with respect to the EER Index. The method currently used in the EER Index is the case deletion method, which in order to be valid demands that no more than 5% of the data is missing and that missing values are missing completely at random (MCAR). For the EER Index, this means that even data missing for one indicator is enough to render this method useless. In the current version of the EER Index, the limit for missing data in order to exclude a certain country from the index is however far more generous, which may imply that another method of imputation of missing data should be considered.

It could be argued that indicators in the EER Index and data for them might be dependent in many cases of some or a few of the other indicators in the index, especially as the extent to which data is possible to collect may depend on the poverty level or the resources available in the country. The indicators of the EER Index would if this assumption holds, not be missing completely at random. Further investigation regarding which imputation method is valid for these indicators and in the EER Index needs to be conducted in order to deduce a legitimate method of imputation of missing values.

However, all imputation methods come with certain assumptions and imputing data into a data set can seduce the user into believing that the data is actually complete (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 25). Therefore, whichever method is used, special consideration should be made to investigate the uncertainty in the estimated data and their inherent statistical properties and meaningfulness (ibid.).

6.3.3 WEIGHTING METHOD

Equal weighting is the most common choice of weighting method when enough is not known about the relationships between indicators or when another alternative for indicator cannot be found, or when there is no empirical or statistical motivation for choosing another method (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008).

This statement raises an interesting question. Should the EER Index hold on to equal weighting in indicators where data is uncertain, until such a time when more adapted weightings can be motivated with regards to data availability, statistical or empirical arguments and when more elaborated relationships between indicators have been found? Or will expert opinions by the JEU, CADRl and the regional offices suffice as grounds for weighting? The authors of this thesis suggest the first approach, since if there is no consensus regarding the weighting, either in opinions or statistical or empirical arguments, the weightings will be based on subjective opinions more strongly.

In the EER Index it is argued that unless indicators can be motivated as being equally important, weightings should be consciously chosen for each and every one (Moriniere (b.), 2014). The JEU has expressed the wish of having a scientifically defensible base for weighting, but for now, since no such base has yet been found for the concept of environmental emergencies, weights have been assigned according to the views of experts connected to the JEU (ibid.).

Weightings will always be subject to a certain degree of personal judgement, which risks enhancing the objective of the index (Jacobs, Smith, & Goddard, 2004; Singh, Murty, Gupta, & Dikshit, 2009, p. 209). This means in the case of EER Index, where the added value is taking into consideration indicators like technological hazards, vulnerability of natural resources and a measure of national capacity to adequately manage the physical environment, there is certain risk that these indicators might be exaggerated. Therefore the interview study is all the more important, in order to broaden the views regarding weighting and render a more objective and locally adapted index that hopefully reflects field experiences to a larger extent. It is in the interest of this thesis to, where possible; provide new input to the weightings of indicators from experiences in field at regional offices. This external investigation is one kind of validation techniques aiming to adjust the index in selection of indicators, scaling, weighting and aggregation in order to improve the quality of the index (Singh, Murty, Gupta, & Dikshit, 2009, p. 197).

6.3.4 AGGREGATION METHOD

Concerning the methods of aggregation in an index, there are several approaches in literature providing guidance on which kind of method to choose in different situations. The EER Index has employed the geometric mean as the method of aggregation which further stresses the importance of changing the remaining interval scale indicators, i.e. Urbanisation and Forest, into ratio scale in order for the aggregation methods to be valid (Ebert & Welsch, 2004). As discussed in section 3.2.6, however, if one holds the belief that indicators in the EER Index should not be able to compensate for lacks or failures in one indicator by good performance in another, suggestions are that multi criteria aggregation methods be considered.

However it is also proposed by Nardo et al. (2008) that the choice of weighting method influences which aggregation methods are allowed in order to create legitimate indices. The BAP weighting method, which is applied in an adapted version in the EER Index, allows all types of aggregation. Which factor that has the final say in deciding which aggregation method is most suitable or allowed is not entirely clear, but in the case of the EER Index it would seem like the scale and comparability of indicators are the determining factors as the choice of weighting method is in this case very permissive.

6.3.5 STEPS AHEAD

In addition to the methodology improvements already mentioned, the authors think it would be desirable to increase the validity of the index, by conducting uncertainty and sensitivity analyses of the results as described in step seven by Nardo et al. (2008). This can be done through going back to the real data after the first results have been generated, and check if there are some certain factors that overly dominate the results (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008). These factors are the ones primarily most important to have secure data on, which is of course a general focus of constructing an index, but as efforts need to be prioritised these driving factors might give the largest benefit for the index as an initial effort. It is also important for policymaking and advocacy to be transparent

(Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008) with how uncertain the results of the index are, and which data are most uncertain and important to improve in order to generate a more reliable result.

In accordance with step eight in constructing an index described by Nardo et al. (2008) it is suggested that results of the EER Index be analysed to determine which indicators bear most importance in determining the results. This could be added to the Excel file of the EER Index as final columns with for example the top three indicators driving the result for each country, in order to increase the application handiness. Even though transparency in the methodology and choices of normalisation, weighting and aggregation is high in the EER Index this may provide users with information on which areas may primarily need attention in for example capacity development interventions for decreasing environmental emergency risk, both on a national level and when informing the international community. As part of this it could also be highlighted where countries lack data in order to advocate for more efforts in data collection.

Another step forward is to compare the EER Index with other related indices or concepts, as described by Nardo et al. (2008) in step nine, in order to see how much they correlate (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008). That would indicate how successful the index is in its strive to measure the environmental emergency risk (ibid.). This is a challenge for this new kind of index, as its objective is unique and data for measuring the exact indicators which are driving environmental emergency risk might not be available. The rate at which the world's environment is changing also exceeds our scientific capabilities to analyse which affects these changes will have (Kaly (b.), Pratt, & Mitchell, 2004, p. 3) which poses additional challenges to this mission. Despite these challenges, and the fact that proxies might need to be used for some indicators, this step may still raise awareness and increase data collection on these issues as the index gains global momentum. One possibility is to relate the results to suitable indices of sustainability, development or environmental performance to see if anticipated correlations match or not and thus how well the EER Index achieves measuring what is intended. This might strengthen the legitimacy of the EER Index as an explanatory for environmental emergencies, as well as aid in further research and development of driving factors and definition.

Finally, as suggested in step 10 in constructing an index described by Nardo et al. (2008), section 3.2.10, forming a baseline for what is considered to be a substantial or even tolerable environmental emergency risk is proposed.

6.4 THE INTERVIEWS

The following section covers the perceptions deduced from the interviews linked to the literature study and to the authors' reflections.

6.4.1 THE DEFINITION OF ENVIRONMENTAL EMERGENCY

Since three out of five interviewees from the regional office do not find the definition of an environmental emergency optimal it can be concluded that there is some ambiguity regarding the concept of environmental emergencies. This could stem from different organisational affiliation and lack of knowledge of the definition. Some interviewees also express the opinion that the definition per se is not what is important, as this will always remain academic and somewhat hard to handle in practice.

The mandate of organisations, in a way, limits them into thinking inside the box according to one of the interviewees. One might contemplate if this is a good or bad limitation, keeping the organisation resource efficient, or hindering the organisation from working within its full potential. One could argue that cross-agency work should be more promoted in order to cover all aspects of disasters and still preserve the mandate. Since the JEU now is mandated to do both response and preparedness work, this could imply that one might consider altering the definition of an environmental emergency.

A small majority of the regional offices and some of the interviewees from the JEU and CADRI expressed that the definition currently lacks a long term aspect at the same time as it is hard to determine what sudden onset is. Regardless of whether this is a question of opinions or an actual fact it is still interesting to discuss the ambiguity in the definition. Currently, the definition does not include environmental disasters that do not affect people (in short term), and does not clearly state how to relate to long term impacts of an event that might trigger vulnerabilities of people and the environment in the future. One might argue that preparedness work includes focusing on preserving the environment so as to limit the effect on human beings and their livelihoods in the long term.

The climate is not constant but ever changing. In many parts of the world, these changes will be more frequent, resulting in an increase of extreme weather events and potential environmental emergencies (Kreft & Eckstein, 2013, p. 5). This will affect the people that are already the most vulnerable (ibid., p. 6) and if something is not done in order to mitigate the effects it can potentially be devastating (ibid., p. 5). In the EER Index, the climate change aspect is currently absent, in the interviews from this study however, four interviewees have expressed a desire to include it. Since climate change is thought to increase the frequency of extreme weather events (ibid.) one could use the aspect as an upwards correction factor for the total risk and thus enable an index that captures the world in a more realistic way. It can also be used to capture the future effects of natural hazards if the objective of the index is to model the potential risk of environmental emergencies in near future as opposed to modelling the past and the risks as they have been historically. In the EPI there is an additional indicator called Climate and Energy (Hsu, et al., 2014) which might to some extent capture this effect. Another suggestion for capturing the climate change effect is investigating the possibilities of using the Global Climate Risk Index[11].

Another thing to aspire for would be clear definitions of what the three concepts of hazards, vulnerability and capacities mean in the context of the EER Index, since the concepts are obviously confused and used somewhat interchangeably. Dividing weights to certain indicators when no clear views regarding which factors belong to which domain exist and

[11] See “Global Climate Risk Index 2014: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012” by Kreft & Eckstein (2013) for more information.

hazards may be given as answers to vulnerabilities and capacities as answers to hazards, may then cause ambiguities.

HAZARD

As mentioned in section 5, the most frequently mentioned hazards are floods, industrial facilities or chemicals, and earthquakes. Floods and earthquakes are categorised under the same indicator in the EER Index, namely the "Sudden Onset Natural Hazards". This could imply that this indicator and the indicator "Industrialisation", where industrial facilities and chemicals are found, should be weighted higher than other indicators of hazards.

VULNERABILITY & CAPACITY

The concept of vulnerability does not appear to have a commonly accepted definition (Birkmann J. , 2006, p. 11). This is made clear when analysing the interview answers, where the opinions and mentioning of vulnerabilities differ. Insufficient infrastructure and corruption are two examples of this where in the EER Index they are sorted under the hazards respectively lack of capacity categories but are mentioned as vulnerabilities by the interviewees. In order to decide where to these indicators belong, one may want to aspire for a commonly agreed definition in order to work more efficiently and aligned, and be able to fully utilise the advantages of the EER Index. How can we measure vulnerability when we cannot define it precisely (ibid.)?

How should one prioritise among these aspects of vulnerability? The interviewees' opinions divided into two groups, one persisting that you cannot rank vulnerabilities since they are all equally important and cannot really be compared with each other, while the other group thought that the vulnerabilities could be ranked and mentioned some that they thought were the most important. The most frequently mentioned vulnerabilities are environmental dependency for livelihoods, any socioeconomic vulnerability and geographic location. These relate closest to the indicators Water, Soil and Vulnerability in the EER Index. When consensus of the weighting cannot be reached, one should according to literature findings in this thesis choose the equal weighting method (Jacobs, Smith, & Goddard, 2004; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005). Maybe should this be done in the EER Index for the category of vulnerability? If not, the suggestion of the authors is to give higher weight to the above mentioned indicators. Another aspect regarding the weighting is the proportion in relation to hazards. Some of the interviewees state that you cannot fully control and remove hazards, so a suggestion would be to give vulnerabilities higher weight than hazards because vulnerabilities are more easily dealt with.

How should one decide what is a direct vulnerability or a capacity or could they be a mix of both? How can this be done practically in the EER Index? If one follows all the assumptions regarding vulnerability and agrees with the statement that vulnerability is the flip side of capacity, then the total weight for capacity should be the same as the total weight for vulnerability, as is currently the case in the EER Index.

LEVEL OF IMPACT ON A COUNTRY

As expressed by the interviewees, countries themselves might not be at risk but could have areas within them that are at a high risk of being struck by environmental emergencies. In indices such as the EER Index these areas might be forgotten if one puts too much trust in the index numbers regarding an entire country. A next step of adjusting the index, suggested by the authors, might be to improve the spatiality of the index and provide sub-national maps of risks as with the case of the Hotspots project discussed by Birkmann (2007). This will of course require additional work with mapping and collecting of data but could also provide additional aid in the prioritisation process. By consulting and cooperating with regional offices, required data might be collected and thus the EER Index would be more locally adapted. As stated by one of the interviewees, regional versions of the index could be made independently and perhaps be integrated with the global EER Index in order to get a more holistic view.

Considering the uneven spatial distribution of risk and the fact that disaster management capacities are generally lower in rural areas (Birkmann J. , 2007, p. 25), the most vulnerable area would be a sparsely populated area suffering from high risk of being struck by an environmental emergency. This statement is aligned with the interviewees concluding that the level of impact of an environmental emergency is dependent on the level of development in a country and the location of the hazardous event. It is however unclear, whether these two are considered to be of equal importance.

KEY ASPECTS

The conclusion from the interviews regarding important factors to consider and implications towards a weighting that might better reflect realities on the ground are the following:

- Within the hazards domain Sudden onset natural hazards and Industrialisation are the indicators most frequently mentioned, which might imply that these hazards should be given higher weighting.
- Within the domain vulnerabilities consensus cannot be reached on whether or not vulnerabilities can be ranked and thus equal weighting among them might be a suggestion.
- Capacity is seen as the flipside of Vulnerability and thus both domains should have equal weighting.
- Some of the interviewees state that you cannot fully control and remove hazards, so a suggestion would be to give vulnerabilities higher weight than hazards because vulnerabilities are more easily dealt with.
- Capacities and Vulnerabilities cannot be clearly defined, and many of the vulnerabilities mentioned in the interviews fall under the Capacity domain of the EER Index.
- Hazards and Vulnerabilities are also confused or not clear to the interviewees as some mention the same aspects as hazards and others as vulnerabilities.

6.4.2 RANKING OF COUNTRIES

The ranking of the countries in ROAP is highly subjective since only one representative from this region was interviewed. All of the countries that were highlighted by the representative from the regional office were also mentioned by interviewees from the JEU and CADRI. The JEU and CADRI also mentioned some additional countries. Two of the three top countries mentioned by the interviewees, i.e. China and India, are said to be unlikely to require any international assistance in case of an emergency which could diminish the argument for these being chosen. At the same time, the JEU has divided their work to include both preparedness and response and as nothing can be said about the countries being willing to participate in capacity development interventions, this ranking could be legitimate.

When comparing this with the EER Index, none of the top three ranked countries in the EER Index, East Timor, Cambodia and Papua New Guinea are mentioned by any of the interviewees which could imply that the index needs to be readjusted or that the index takes some other aspects into account that the interviewees did not do and vice versa.

The top three countries in the EER Index for the region of Caucasus and Central Asia are Tajikistan, Azerbaijan and Kyrgyzstan. Azerbaijan is the only country of these three not mentioned by any of the interviewees. The rankings of the countries were based on answers from three participants which could raise the level of objectivity compared to the other regions, but the interviewees also stemmed from different organisations and might thus be focused in different areas. The border limitations for the region also seem to be different for the organisations that participated as one country was mentioned that does not belong to the OCHA definition of the region. Multiple interviewees from JEU and CADRI at the same time stated that they were not very familiar with the region which can also be seen in the answers as some countries mentioned do not belong to the region. This problem could of course have been avoided by providing the interviewees with a map (which was done for the JEU and CADRI) or a list of countries. As the authors of this thesis wanted to avoid interfering with the perceptions as much as possible and influence interviewees as little as possible, this action was disregarded in interviews with regional offices.

As in the case with ROAP, the ranking of the countries in the region of Southern Africa is also subjective since only one representative from this region was interviewed. Of the top three ranked countries in the EER Index, one country was not mentioned by any of the interviewees from either JEU and CADRI or the regional office. The representative from ROSA also chose one country that was not mentioned by either the JEU or CADRI and, as mentioned before, this could entail that readjustments of the EER Index are needed but could also reflect the subjectivity in having only one regional representative.

The opinions regarding which aspects contribute most to environmental emergencies differ between the JEU, CADRI and the regional offices, which could imply that they are not particularly aligned. At the same time, as mentioned above, there is only one opinion from two out three the regional offices and not of all the interviewees from JEU and CADRI are very familiar with each of the regions.

6.4.3 USEFULNESS OF EER INDEX

By using an index like the EER Index one hopefully receives additional help in the prioritisation of capacity development interventions. If a country requires assistance, the index could be used to motivate both why and why not assistance would be provided. The index would also aid in the advocacy for preparedness regarding environmental emergencies. In the current situation however, the EER Index is not perceived as enough precise in its scientific arguments to be used as evidence or justification.

OCHA ROCCA has developed their own vulnerability analysis and will likely adapt InfoRM and EER Index to a lower administrative level in order to use it at a regional level, one interviewee stated. What will the consequences then be for the interaction between the two levels of offices? One of the interviewees expressed concerns regarding JEU holding the money and a certain perspective of risk in combination with the results derived from the global EER Index, and how this will affect the regions abilities to motivate and advocate for international assistance if their regional index and the EER Index contradict each other. To align the work, the index must be adapted for regional purposes at a global level, which will hopefully enable a more holistic picture of the world. However the EER Index is only part of the answer to countries' requests for aid, together many other aspects and criteria.

DATA COLLECTION AND QUALITY

From the interviews in the different regions it is understood that data is not easy to collect even if there are national data bases. According to the interviewees, in some countries the governments are not willing to share the information since this type of data is politically tied, while in others the databases have just been established and are therefore differing both qualitatively and quantitatively. The databases might even be deliberately set up so that they are manually operated and hard to understand even if the government states that they are willing to share and some countries might even avoid measuring some hazards, interviewees explain. A solution must be provided in order to collect the right data and it could be that organisations must collect data themselves even if it is time consuming. Of course, that cannot be applied for every country or region. When collecting data on your own, you can also decide what to collect and thus get the proper data and not proxy indicators which will enable indices more close to reality. New technology, such as satellite imagery was suggested by one of the interviewees, to find information on for example industrial locations. This could be of help in this matter but then the problem of for example, knowing exactly what was contained in the mapped industries would remain.

Another food for thought was expressed by Hsu, Johnson, & Lloyd (2013) as *"Data may be easier to collect for an index that is tightly focused and spans a small geographic area. It can also translate into a more narrow definition and selection of indicators. On the other hand, defining scope and scale too narrowly may be limiting and thus unintentionally exclude potentially interested users."*. By involving the regional offices and making regional versions of the EER Index this will take those two into consideration and the index will be more justified and precise and enable improved cooperation processes between the different offices.

6.5 CASE STUDY METHODOLOGY

Qualitative research methods such as the case study through interviews which was used in this thesis bear the advantage, compared to quantitative methods, of evoking unanticipated answers (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). In addition the answers may be more comprehensive and rich in details (ibid.).

This was much of the pursuit in the thesis, to gain new insights into areas where the EER Index might benefit from improvements and into the current perceptions of field staff or experts. The insights were, at regional level and CADRI, obtained without influencing the interviewee too much by providing the draft version of the model from start, whereas in the case of JEU most interviewees were more accustomed with the model. In all the interviews, the questions were asked open-ended in order to get a clearer picture of the themes and patterns that the interviewees found most important and relevant.

The data collected in this case study are qualitative and not quantitative, as they describe in words and personal accounts of what is perceived in the field. Such qualitative data demand certain types of methods of analysis based on sorting and categorisation (Höst, Regnell, & Runeson, 2006). The analysis draws out patterns from insights and concepts, since in a qualitative analysis it is not meaningful to talk about how many of the total number have mentioned a certain word or concept (ibid.). Rather, the emphasis is on the actual mentioning of the word and the description and perception of it from the interviewee's point of view (ibid.). However, in this thesis, the number of interviewees mentioning certain words or concepts has been included upon request and also to highlight certain deviating or unexpected responses where they occur. The method of analysis identifies themes or patterns in the answers of the interviews rather than trying to detect predetermined keywords (ibid.). This reflects the aim of the thesis, namely trying to illustrate which perceptions exist with experts and field staff in order to meliorate the EER Index rather than trying to fit perceptions into the current scope of it. The representativeness of the results from case studies cannot be made general, unless the contexts are very similar (ibid.).

The compilation of the results from the interviews is inevitably subjected to personal interpretations of statements from interviewees, and might have been more objective and generated a broader analysis if more than one of the authors were to have compiled the key information points. Due to time limitations this has however not been possible within the scope of this study.

6.6 LIMITATIONS OF THE THESIS

The literature study of this master thesis makes no claim of being exhaustive for all research and progress within the concerned fields, but are kept as best possible within the relevance and scope of the study.

As previously mentioned, the findings from case studies cannot be statistically generalized for entire regions or other regions in the world (Höst, Regnell, & Runeson, 2006). Another limitation of the transferability of the findings from this study to the general case is the limited number of interviewees from some of the regions. The reliability of the findings would possibly have been greater if a larger number of interviewees had been represented from each region, but also if representatives from a larger set of organisations had been interviewed (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 66). The fact that many of the interviewees belonged to the same organisation, may both have been a weakness and a strength. It may be a weakness because it might make the EER Index too narrow in its applicability and relevance for a broad range of organisations and thus limit its possibilities of becoming a global standard for assessing environmental emergency risk. At the same time it might prove a strength in the line of work of the JEU since a majority of the interviewees are most tightly connected to this organisations, while it is of course also true that the more organisations that give input to and enhance the EER Index, the more useful it will be in a more global perspective and across the lines of work of more organisations. More stakeholder input will strengthen the institutional ownership of the index as well as increase the likelihood of the persistence of the index and its policy uptake and contribute with local knowledge and improved cost effectiveness (de Sherbinin, Reuben, Levy, & Johnson, 2013).

In the case of regions and the number of representatives from each region, this differs somewhat. On the one hand more interviewees were obtained from the region that the JEU interviewees stated they had least knowledge about, which is a strength for the EER Index and a great gain of knowledge for the JEU, on the other hand as discussed above more stakeholders from each region would have improved the legitimacy of the index in a number of areas.

7. CONCLUSIONS

The aim of the thesis has been to investigate to what extent the EER Index reflects expert and field staff perceptions regarding environmental emergency risk. The thesis answers the research questions *"What environmental indicators are important for ranking country environmental emergency risk?"* and *"To what extent does the EER Index fit field staff and expert perceptions of realities on the ground?"*.

The EER Index was developed for the JEU to propose a prioritisation index in line with the unit's mandate (Moriniere (a.), 2014). Its purpose is to assist the JEU in prioritising capacity development efforts. Additionally it is useful as an advocacy tool and a tool for raising interest in disaster-environment linkages by showing the close links between environment and technological hazards as well as the need to include these links into a multi-hazard approach (UNISDR, 2005).

In order to motivate why efforts are being made in one country and not the other, the JEU has long desired to develop a more evidence-based ground for decision making in these matters (Moriniere (b.), 2014). This evidence base should be scientifically linked to the likelihood of events constituting in themselves, or causing as a secondary effect, environmental emergencies but should also be linked to the current capacity of the country requesting aid (ibid.).

The interviews reveal that important indicators to consider when evaluating environmental emergency risk include industrialisation processes, natural hazards and climate change, as well as environmental dependency for livelihood, deteriorated infrastructure, geographic location and socioeconomic vulnerabilities. Results also show that currently absent factors such as capacity to respond and a long term factor are desirable in the definition of an environmental emergency.

From the theoretical background and the 11 interviews conducted it can also be concluded that the perceptions of the experts and people working in the field do not coincide very well with the first draft of the EER Index and that more research is needed regarding the choice of indicators as well as regarding the analytical and mathematical methodology with respect to uncertainty and sensitivity analysis to increase the legitimacy and credibility of the index.

The following are some of the authors' suggestions, based on both literature findings and interviews, on steps ahead in possible improvements for the EER Index.

In order to increase the validity of the index, uncertainty and sensitivity analysis of the results should be made and the index should be compared with other related indices and concepts in order to see how much they correlate and thus if the EER Index is unique and if it measures what it is supposed to measure.

To deal with skewedness in the EER Index, it is not recommended to use the log transformation for all values since it only applies to data that is positively skewed. Methods to use when data is negatively skewed should be investigated.

The scope of investigation for the EER Index should also be broaden by searching for more input to the relationships between current and potential additional indicators, and environmental emergencies in order to find the main drivers for the risk.

Using change percentage as a measurement for an indicator, which belongs to interval scales, is not meaningful for the EER Index since most of the indicators belong to ratio scales and thus the index cannot be aggregated. It is recommended that the indicators, Urbanisation and Forest, using these measurements should be converted to ratio scales.

The Industrialisation indicator is recommended to change its measurements to relate the number of employees within the industrial sector to the population size and the population density instead of using number of employees as a measurement since it does not really reflect the hazard.

The Urbanisation indicator, which may assume negative values, should be converted to ratio scale by adding the same constant (the most negative value) to all values. The current conversion exaggerates the risk for countries where urbanisation is decreasing.

The indicators Road density and Water in the EER Index are partly included in the InfoRM indicator Lack of coping capacity which is used in the EER Index as the indicator for capacity. This can cause double counting and have negative implications for the meaningfulness of the EER Index. Recommendations for this issue are to exclude the sub-indicators from the InfoRM indicator before it is integrated into the EER Index or to investigate the possibility of using other indicators to describe the issue of transport of hazardous materials and access to drinking water and sanitation respectively.

In the EER Index, the climate change aspect is currently absent. In the 11 interviews, four interviewees have expressed a desire to include it. Since climate change is thought to increase the frequency of extreme weather events it is suggested that the possibilities of integrating a climate change aspect or indicator into the EER Index should be investigated. One suggestion is to account for this by using an upwards correction factor in the form of Global Climate Risk Index or to include another indicator from the EPI called Climate and Energy.

Some of the most pin pointed hazard indicators in the interviews were floods and earthquakes, and industrial facilities/chemicals. Thus, among hazards it might be reason enough to weight the two indicators Sudden onset natural hazards and Industrialisation higher than the rest of the proposed hazards.

The prioritisation of vulnerability indicators divided the interviewee opinions into two groups, one persisting that you cannot rank vulnerabilities and one group meaning that the vulnerabilities can be ranked and mentioning some that they thought were the most important. Since consensus of the weighting could not be reached, the recommendation is to use equal weighting amongst the indicators under the vulnerability domain.

However, if one does not agree that Vulnerabilities cannot be ranked, the most frequently mentioned vulnerabilities environmental dependency for livelihoods, any socioeconomic vulnerability and geographic location should be given higher weight. These relate closest to the indicators Water, Soil and Vulnerability in the EER Index.

Capacity is by the interviewees perceived to be the flip side of vulnerability. If the assumptions of vulnerability are followed, then it could be argued that the weights given should be equally distributed and the total weight for capacity should be the same as the total weight for vulnerability, which is also currently true for the EER Index.

When data is uncertain, it is recommended that equal weighting is chosen until more adapted weightings can be motivated.

The definition of environmental emergency is by the interviewees not perceived as optimal since it is deemed to lack a long term aspect. A suggestion for a step forward could be to investigate the meaning of the definition as it is and try to rephrase it. Another thing to aspire for would be clear definitions of what the three concepts of hazards, vulnerability and capacities mean in the context of the EER Index.

Another step in adjusting the index, suggested by the authors, might be to improve the spatiality of the index and provide sub-national maps of risks. This will of course require additional work with mapping and data collection but could aid in the prioritisation process. By consulting and cooperating with the regional offices, the required data might be obtained and thus the EER Index could be improved.

The ranking of countries in the EER Index is not perceived to be very well aligned with the opinions of the interviewees. This could imply that the index needs to be readjusted or that the index takes some other aspects into account that the interviewees did not and vice versa. The recommendation for this is to investigate further what the reasons could be.

By using an index like the EER Index one hopefully receives additional help in the prioritisation of capacity development interventions. If a country requires assistance, the index could be used to motivate both why and why not assistance would be provided. The index would also aid in the advocacy for preparedness regarding environmental emergencies. In the current situation however, the EER Index is not perceived as enough precise in its scientific arguments to be used as evidence or justification.

Finally, forming a baseline for what is considered to be a substantial or even tolerable environmental emergency risk is proposed in order to determine what high risk is and what low risk of environmental emergencies is, in order to improve resource efficiency.

REFERENCES

Akbayrak, B. (2000). A Comparison of Two Data Collection Methods: Interviews and Questionnaires. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi 18*, 1-10.

Alkire, S., & Foster, J. (2010). *Designing the Inequality-Adjusted Human Development Index (IHDI)*. United Nations Development Programme.

Barnett, J., Lambert, S., & Fry, I. (2008). The Hazards of Indicators: Insights from the Environmental Vulnerability. *Annals of the Association of American Geographers, 98*, 102-119.

Birkmann, J. (2006). *Measuring Vulnerability to Natural Hazards: towards disaster resilient societies*. New Dehli: United Nations University.

Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. *Environmental Hazards 7*, 20-31.

Box, G. E., & Cox, D. R. (1964). An Analysis of Transformations. *Journal of the Royal Statistical Society. Series B (Methodological), Vol. 26, No.2.*, 211-252.

Bureau d Analyse des Risques et Pollutions Industriels. (2010). *2010 INVENTORY OF TECHNOLOGICAL ACCIDENTS*. Lyon: French Ministry of Ecology, Energy, Sustainable Development and the Sea.

Buthmann, A. (2010, February 26). *Making Data Normal Using Box-Cox Power Transformation*. Retrieved March 19, 2014, from iSixSigma: http://www.isixsigma.com/tools-templates/normality/making-data-normal-using-box-cox-power-transformation/

Butler, C. (1985). *Statistics in Linguistics*. Oxford: Blackwell.

Böhringer, C., & Jochem, P. E. (2007). Measuring the immeasurable — A survey of sustainability indices. *Ecological Economics*, 2-8.

CADRI. (n.d.). *Who we are*. Retrieved March 27, 2014, from CADRI: http://www.cadri.net/en/about-us#un-entities

Cardona, O. D., Hurtado, J. E., Chardon, A. C., Duque, G., Velásquez, L. S., Moreno, A., et al. (2003). *Indicators for Risk Measurement: Methodological Fundamentals*. Manizales: Instituto de Estudios Ambientales.

Chang, R. (2013). Incommensurability (and incomparability). In H. (. LaFollette, *The International Encyclopedia of Ethics*. Wiley-Blackwell.

Craig, T., & de Groeve, T. (2013, May 22). Towards an Open Humanitarian Risk Index. IASC & Joint Research Centre of the European Commission.

de Groeve, T., Poljansek, K., & Vernaccini, L. (2014). *Index for Risk Management - InfoRM; Concept and Methodology Version 2014*. Luxembourg: European Commission Joint Research Centre, Publications Office of the European Union.

de Sherbinin, A., Reuben, A., Levy, M. A., & Johnson, L. (2013). *Indicators in Practice: How Environmental Indicators are Being Used in Policy and Management Contexts*. New Haven and New York: Yale and Columbia Universities.

Dunn, R. L. (2013, February 20). *Bivariate - Pearson Correlation Coefficient*. Retrieved March 25, 2014, from Experts: https://experts.missouristate.edu/display/csvhelpdesk/Bivariate+-+Pearson+Correlation+Coefficient

Ebert, U., & Welsch, H. (2004). Meaningful environmental indices: a social choice approach. *Journal of Environmental Economics and Management 47*, 270-283.

Foddy, W. (1993). *Constructing Questions for Interviews and Questionnaires: Theory and practice in social research* . Cambridge: Cambridge University Press.

Fortmann-Roe, S. (2012, June). *About Scott Fortmann-Roe*. Retrieved March 31, 2014, from Understanding the Bias-Variance Tradeoff: http://scott.fortmann-roe.com/docs/BiasVariance.html

Gauthier, T. D. (2001). Detecting Trends Using Spearman's Rank Correlation Coefficient. *Environmental Forensics 2*, 359-362.

Giannetti, B., Bonilla, S., Silva, C., & Almeida, C. (2009). The reliability of experts' opinions in constructing a composite environmental index: The case of ESI 2005. *Journal of Environmental Management 90*, 2448–2459.

Harris, L. R., & Brown, G. T. (2010). Mixing interview and questionnaire methods: Practical problems in aligning data. *Practical Assessment Research & Evaluation, Vol. 15, No. 1*, 1-19.

Hauke, J., Kossowski, & Tomasz. (2011). *Comparison of values of Pearson's and Spearman's correlation coefficients on the same sets of data*. Poznań: Adam Mickiewicz University, Institute of Socio-Economic Geography and Spatial Management.

Hsieh, N.-h. (2007, July 23). *The Stanford Encyclopedia of Philosophy*. Retrieved March 12, 2014, from Incommensurable Values: http://plato.stanford.edu/entries/value-incommensurable/

Hsu, A., Emerson, J., Levy, M., de Sherbinin, A., Johnson, L., Malik, O., et al. (2014). *The 2014 Environmental Performance Index*. New Haven: CT: Yale Center for Environmental Law and Policy.

Hsu, A., Johnson, L., & Lloyd, A. (2013). *Measuring Progress: A Practical Guide from the Developers of the Environmental Performance Index (EPI)*. New Haven: Yale Center for Environmental Law & Policy.

Höst, M., Regnell, B., & Runeson, P. (2006). *Att genomföra examensarbete*. Lund: Studentlitteratur AB.

IASC, JRC & OCHA. (2014, March 26). *Index for Risk Management (InfoRM)*. Retrieved March 26, 2014, from Index for Risk Management (InfoRM): http://inform.jrc.ec.europa.eu/

Jacobs, R., Smith, P., & Goddard, M. (2004). *Measuring performance: An examination of composite performance indicators*. York: Centre for Health Economics, University of York.

Jakobsen, S., Stuart, R., & Draggan, S. (2008, May 17). *The Encyclopedia Of Earth*. Retrieved March 13, 2014, from Environmental indicators: http://www.eoearth.org/view/article/152625/

Joint UNEP/OCHA Environment Unit. (2013, July 9). Developing National Capacities for Environmental Emergencies: Proposal for a Study on Integrating Environment into Humanitarian Risk DRAFT. Geneva, Switzerland: Joint UNEP/OCHA Environment Unit.

Joint UNEP/OCHA Environment Unit. (2014, March 3). JEU support to member states on environmental emergency preparedness. Geneva.

Kaly (a.), U., Briguglio, L., McLeod, H., Schmall, S., Pratt, C., & Pal, R. (1999). *Environmental Vulnerability Index (EVI) to summarise national environmental vulnerability profiles*. SOPAC Technical Report 275.

Kaly (b.), U., Pratt, C., & Mitchell, J. (2004). *The Environmental Vulnerability Index (EVI) 2004*. SOPAC.

Kreft, S., & Eckstein, D. (2013). *Global Climate Risk Index 2014: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012*. Bonn: Germanwatch.

Mack, N., Woodsong, C., MacQueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative Research Methods: A data collector's field guide*. Family Health International.

Moriniere (a.), L. C. (2014, January 7). Environmental Emergency Risk (EER) Index Leading to: the Prioritization of Capacity Building Efforts. Geneva, Switzerland: United Nations Office for the Coordination of Humanitarian Affairs.

Moriniere (b.), L. C. (2014, February 22). JEU Environmental Emergency Risk (EER) Index: An effort to Prioritize Capacity Building.

Moriniere (c.), L. C. (2014, February 24). EER Datapack v24Feb2014 Final.

Moriniere (d.), L. C. (2014, February 22). JEU_EERindex_DataBase_v22Feb2014.

Nardo (a.), M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., & Giovannini, E. (2008). *Handbook on Constructing Composite Indicators - Methodology and User Guide*. OECD.

Nardo (b.), M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). *Tools for Composite Indicators Building*. Ispra: European Commission Joint Research Centre.

OCHA (a.). (n.d). *OCHA in Asia and the Pacific*. Retrieved March 6, 2014, from UNOCHA Asia and the Pacific: http://www.unocha.org/roap/about-us/about-ocha-roap

OCHA (b.). (n.d). *About OCHA Regional Office of Caucasus and Central Asia*. Retrieved March 6, 2014, from UNOCHA Caucasus and Central Asia: http://www.unocha.org/rocca/about-us/about-ocha-rocca

OCHA (c.). (n.d). *About OCHA Regional Office for Southern Africa (ROSA)*. Retrieved March 6, 2014, from UNOCHA Southern Africa: http://www.unocha.org/rosa/about-us/about-ocha-rosa

OCHA (d.). (n.d.). *History of OCHA*. Retrieved April 14, 2014, from United Nations Office for the Coordination of Humanitarian Affairs.: www.unocha.org/about-us/who-we-are/history

OCHA (e.). (n.d). *Who We Are*. Retrieved January 10, 2014, from United Nations Office for the Coordination of Humanitarian Affairs.: http://www.unocha.org/about-us/who-we-are

OCHA (f.). (n.d). *Environmental Emergencies*. Retrieved January 10, 2014, from United Nations Office for the Coordination of Humanitarian Affairs.: http://www.unocha.org/what-we-do/coordination-tools/environmental-emergencies

Osborne, J. W. (2010). Improving your data transformations: Applying the Box-Cox transformation. *Practical Assessment, Research & Evaluation, Volume 15, Number 12*, 1-9.

Pelling, M. (2004). *Visions of Risk: A Review of International Indicators of Disaster Risk and its Management*. London: ISDR Inter-Agency Task force.

Rao, S. (2013). *Helpdesk Research Report: Regional and national capacity to cope with humanitarian risk*. Governance and Social Development Resource Centre.

ReliefWeb. (2013, March 11). *ReliefWeb*. Retrieved January 17, 2014, from Helpdesk Research Report: Regional and national capacity to cope with humanitarian risk: http://reliefweb.int/report/world/helpdesk-research-report-regional-and-national-capacity-cope-humanitarian-risk

Singh, K. R., Murty, H. R., Gupta, S. K., & Dikshit, A. K. (2009). An overview of sustainability assessment methodologies. *Ecologic Indicators 9*, 189 - 212.

Slovic, P. (2001). The risk game. *Journal of Hazardous Materials 86*, 17-24.

Smeets, E., & Weterings, R. (1999). *Environmental indicators: Typology and overview*. Copenhagen: European Environment Agency.

Statistics Unit, UNIDO. (2010). *World statistics on mining and utilities*. Vienna: UNIDO.

ten Brink, B. (2006). *Indicators as communication tools: an evolution towards composite indicators*. ALTER-Net.

Transparency International. (2013). *Results*. Retrieved March 17, 2014, from Corruptions Perceptions Index 2013: http://cpi.transparency.org/cpi2013/results/

UNDP. (2014). *A world of development experience*. Retrieved March 27, 2014, from United Nations Development Programme: http://www.undp.org/content/undp/en/home/operations/about_us/

UNEP. (2003). FURTHER IMPROVEMENT OF ENVIRONMENTAL EMERGENCY PREVENTION, PREPAREDNESS, ASSESSMENT, RESPONSE AND MITIGATION. *Twenty-second session of the Governing Council/ Global Ministerial Environment Forum* (p. 14). Nairobi: Governing Council of the United Nations Environment Programme.

UNEP. (n.d). *About UNEP*. Retrieved January 10, 2014, from United Nations Environment Programme.: http://www.unep.org/About/

UNIDO. (n.d). *IndStat2 2013 Data Availability*. Retrieved March 12, 2014, from INDSTAT2 - 2013 edition: http://www.unido.org/Data1/Statistics/Databases/ISAV.cfm?dig=2

UNISDR. (2005, December 22). *General Assembly 60th Session*. Retrieved April 14, 2014, from UNISDR: http://www.unisdr.org/files/resolutions/N0549936.pdf

UNISDR. (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Geneva: UNISDR.

UNISDR. (2013). *Prevention Web*. Retrieved January 10, 2014, from Joint UNEP/OCHA Environment Unit (JEU): http://www.preventionweb.net/english/professional/contacts/profile.php?id=11314

UNOCHA. (2012, October 3). *OCHA's Work In Asia and the Pacific Focues On Four Key Areas*. Retrieved March 31, 2014, from Promotial Materials: https://docs.unocha.org/sites/dms/ROAP/Promotional%20Materials/OCHA-main.pdf

Welsch, H. (2005). Constructing Meaningful Sustainability Indices. In C. Böhringer, & A. Lange, *Applied Research in Environmental Economics* (pp. 7-22). Physica-Verlag HD.

Wexler, P., van der Kolk, J., Mohapatra, A., & Agarwal, R. (2012). *Chemicals, Environment, Health: A Global Management Perspective*. Boca Raton: CRC Press.

Williams, C., & Marinos, J. (2013). *2013 Global Focus Model*. United Nations Office for the Coordination of Humanitarian Affairs.

World Health Organization. (n.d.). *What is CVRS?* Retrieved March 24, 2014, from The Global Summit on Civil Registration and Vital Statistics: http://www.globalsummitoncrvs.org/crvs.html

Yale University (a.). (n.d.). *Forests*. Retrieved March 14, 2014, from Environmental Performance Index: http://epi.yale.edu/our-methods/forests

Yale University (b.). (n.d.). *Water and Sanitation*. Retrieved March 14, 2014, from Environmental Performance Index: http://epi.yale.edu/our-methods/water-and-sanitation

Yale University (c.). (n.d.). *Air Quality*. Retrieved March 14, 2014, from Environmental Performance Index: http://epi.yale.edu/our-methods/air-quality

Yale University (d.). (n.d). *Biodiversity and Habitat*. Retrieved March 14, 2014, from Environmental Performance Index: http://epi.yale.edu/our-methods/biodiversity-and-habitat

Yale University (e.). (n.d.). *Our Methods*. Retrieved March 17, 2014, from Environmental Performance Index: http://epi.yale.edu/our-methods

Zumel, N., & Mount, J. (2013, May 27). *LOG TRANSFORMATIONS FOR SKEWED AND WIDE DISTRIBUTIONS*. Retrieved March 18, 2014, from R-statistics blog: http://www.r-statistics.com/2013/05/log-transformations-for-skewed-and-wide-distributions-from-practical-data-science-with-r/

APPENDICES

A. INDICES

HUMAN DEVELOPMENT INDEX (HDI)

The Human Development Index is an index currently used for analysing development work, but there is a gap in representation of resilience-building and humanitarian action (IASC, JRC & OCHA, 2014). Several organisations maintain their own indices for analysing humanitarian risk, but there is currently not a widely-accepted index used (ibid.).

GLOBAL FOCUS MODEL (GFM)

The Global Focus Model, which constitutes one of cornerstones of InfoRM, was developed by UNOCHA's Regional Office for Asia and Pacific (ROAP) in 2006 to address the challenge of how to ensure that resources were allocated where they were most needed (Craig & de Groeve, 2013). The index was designed to analyse, hazards, vulnerabilities and response capacity at country level with the use of quantitative indicators and the output would be hazard-prone countries that combined high vulnerabilities to hazards and low capacities (Williams & Marinos, 2013). These countries were then estimated to be more likely to request or accept international support (ibid.).

INDEX FOR RISK MANAGEMENT (INFORM)

InfoRM is an index based on the GFM, ECHO's Global Needs Assessment (GNA) and Forgotten Crisis Index (FNI) (de Groeve, Poljansek, & Vernaccini, 2014, p. 12). To address the gap in representation of resilience building and humanitarian action, a group of UN agencies, donors and research institutions have developed the InfoRM (ibid., p. 7). The group proposes a comprehensive, widely-accepted and open-evidence based multi-hazard humanitarian risk index with global coverage and regional/subnational scale and seasonal variation (ibid.). The main users of this index are different humanitarian organisations and other actors with a resilience agenda, which are thus focused on anticipating, mitigating, and preparing for humanitarian emergencies (IASC, JRC & OCHA, 2014; de Groeve, Poljansek, & Vernaccini, 2014, p. 8). The index constitutes of the following five core principles (de Groeve, Poljansek, & Vernaccini, 2014, p. 22):

1. Global coverage
2. Openness
3. Continuity
4. Transparency
5. Flexibility

The primary role of the index is to conclude which countries are at risk of humanitarian crisis and this most in need of humanitarian assistance (de Groeve, Poljansek, & Vernaccini, 2014, p. 8). The index also serves to try to predict which countries will need international assistance in the near future (ibid.). In the same way that the HDI has become a standard and a single statistic serving as a frame of reference for both social and economic development, the

InfoRM is likely to become its parallel in tracking the evolution of risk of disasters, emergencies and crises (Moriniere (a.), 2014).

B. INTERVIEW QUESTIONS

The following questions were asked to all interviewees, with the exception of a few questions that were unique for some interviewees.

1. What is your name?
2. What is your position?
3. Based on your own work experience, which incidents were you involved in that you would classify as an environmental emergency? (If several, which ones in particular stand out? Why?)
4. What, in your opinion, constitutes an environmental emergency?
5. The JEU works by the UNEP definition where an environmental emergency is defined as:
   "a sudden onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that cause or threaten to cause severe environmental damage as well as harm to human health and/or livelihoods."

   How well do you think this definition correlates with you own perception of what an environmental emergency is?

6. In your opinion, which type of hazards cause environmental emergencies?
   a. Considering the proposed hazards, which one would you give higher priority?
   b. Why?
7. What vulnerabilities in relation to environmental emergencies are important to consider?
   a. Considering proposed vulnerabilities, which one would you give higher priority?
   b. Why?
8. How do you experience the prioritisation of capacity development interventions?
   a. In your opinion, what factors should be considered?
   b. Why?
9. Focusing on the regions Southern Africa, Asia/Pacific, Caucasus/Central Asia, which three countries would you rank as most prone to environmental emergencies?
   a. Why?

http://www.unocha.org/rocca/about-us/about-ocha-rocca

http://www.unocha.org/roap/about-us/about-ocha-roap

http://www.unocha.org/rosa/about-us/about-ocha-rosa

10. What tools are you currently using for evaluating environmental risks?
    a. What are the strengths and weaknesses of these tools? Motivate.

b. If no: why not? (Suggestions: lack of tools, lack of time, lack of knowledge…) If no: should such a tool be available, would you be interested in applying it in your region/globally?

11. What would be the added value of an environmental emergency risk index model?
12. For what purposes would you use an environmental emergency risk tool/model? (Suggestions: programming, analysis, information sharing, strategic decision making)
13. Do you think there are any national datasets that contain information statistics regarding hazards, vulnerabilities and capacities? (Transport of hazardous materials, etc.)

1. Industrialization,
2. Urbanization,
3. Mining/Utilities,
4. Dams,
5. Road/Rail Density,
6. Sudden Onset Natural Hazards,
7. Conflict (Human Hazards),
8. Forests,
9. Water,
10. Soil,
11. Air,
12. Biodiversity,
13. Human (Population density),
14. Human Vulnerability (InfoRM),
15. Environmental Performance,
16. Corruption,
17. Capacity

a. If yes: Would you have access to these kinds of data sets?

b. If no: How difficult do you think it would be to construct such collecting of data in your specific region? Are there any specific problems or obstacles as you see it?

C. THE UN ORGANISATIONS

The following organisations have involved in one way or the other in the process of making this thesis.

UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS (UNOCHA)

UNOCHA was founded in 1998 when the Department of Humanitarian Affairs (DHA) was reorganised (OCHA (d.), n.d.). UNOCHA has the mission to *"Mobilize and coordinate effective and principled humanitarian action in partnership with national and international actors in order to alleviate human suffering in disasters and emergencies, advocate the rights of people in need, promote preparedness and prevention, facilitate sustainable solutions."* (OCHA (e.), n.d). More concretely, UNOCHA assists countries requesting help in situations where an emergency has caused severe humanitarian consequences, through coordination and mobilisation of international assistance and partners (OCHA (f.), n.d).

UNITED NATIONS ENVIRONMENTAL PROGRAMME (UNEP)

UNEP was established in 1972 to form the voice of the environment within the United Nations (UNEP, n.d). The mission of UNEP *is "to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."*(ibid.). The mandate of UNEP is *"to be the leading global environmental authority that sets the global environmental agenda, that promotes the coherent implementation of the environmental dimensions of sustainable development within the United Nations system and that serves as an authoritative advocate for the global environment."* (ibid.).

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)

UNDP was formed in 1966 with the intention of aiding people and countries in their work of building a crisis resistant society and to achieve a sustainable development (UNDP, 2014). In order to enable this, their focus is directed on providing solutions for poverty reduction, the Millennium Development Goals (MDGs), democratic governance, crisis prevention and recovery and for the environment and energy (ibid.).

CAPACITY FOR DISASTER RISK INITIATIVE (CADRI)

CADRI is an interagency initiative between the United Nations Development Programme Bureau of Crisis Prevention and Recovery (UNDP/BCPR), the secretariat of the United Nations International Strategy for Disaster Reduction (UNISDR secretariat) and OCHA (CADRI, n.d.). By connecting these three organisations, the initiative aims to increase the efforts made in sustainable and resilient capacity development for disaster risk reduction (ibid.).

D. COMPARABILITY AND COMMENSURABILITY

When indicators are comparable, contrasting different environmental states is unproblematic, while in the latter case when indicators are non-comparable problems arise (ibid.). However, there are ways in which also non-comparable indicators can be aggregated so as to create meaningful indices in the definition of Ebert & Welsch (2004).

Commensurability between indicators demands the same ordinal ranking between the entities compared in the index, e.g. countries in the case of EER Index, indifferent of the measurement unit or aggregation method used (Böhringer & Jochem, 2007). Commensurable indicators generate unambiguous rankings of different situations, since any choice of measurement units can be described by exogenous relationships between the indicators (Welsch, 2005). Incommensurable indicators may however render ambiguous rankings of situations depending on the measurement units used for the indicators, which is not desirable when constructing a meaningful environmental index (Welsch, 2005).

Comparability and commensurability are closely tied concepts. Some scientists and philosophers are therefore using the terms interchangeably while others differentiate one from the other (Chang, 2013; Hsieh, 2007). Commensurable means that the entities have a common measure (ibid.). For instance, you can compare the side and the diagonal of a square since the diagonal is longer, but without the use of irrational numbers you will not be able to specify with cardinal numbers exactly how much longer the diagonal is (ibid.). Incommensurable then means that you can compare entities, but not cardinally or precisely, thus by numerically measuring the difference between the alternatives for ranking (ibid.). Incommensurable indicators can be defined basically as "lacking a common measure" or failing to have cardinal measurability (Chang, 2013). Comparability suggests that ordinal comparison or rankings are possible (Hsieh, 2007), thus ranking by qualitative measures such as better, longer, faster but not saying how much better, longer or faster.

However, even if indicators lack a common measure and are incommensurable, they may still be comparable (Chang, 2013). Commensurability is only one way in which indicators may be comparable (ibid.). Comparability builds on there being some positive value relation between indicators with respect to some covering consideration (ibid.). An indicator cannot be simply better than another without considering some overall criteria (ibid.) such as tastiness or environmental emergency risk.

Non-comparability is by some used as a synonym for incomparable while other do the following distinction:

Non-comparable indicators have at least one indicator which is not covered by the covering consideration required in order to make comparisons between them at all (Chang, 2013). That is for example a chair and the number four cannot be compared regarding how comfortable they are to sit upon, since the number four fails to fall within the application of the word comfortable.

Incomparable indicators have no positive value relation between them with regard to a certain covering criteria (Chang, 2013). For example it is not possible to say which one of buildings and chairs are tastier, both objects could theoretically be tasty and could be compared but it is not possible to quantify or rank either cardinally or ordinally which one is tastier and thus they are incomparable with regard to tastiness.

E. NORMALISATION METHODS

Some normalisation procedures are invariant to changes in units as they provide the same ranking regardless of the unit, while others are not (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 84; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 44). Using a non-invariant normalisation procedure could result in different outcomes for the index (ibid.). The following normalisation methods are all invariant (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 44):

1. **Ranking:** Ranking is one of the simpler methods of normalisation of data where you simply rank data from lowest to highest or vice versa across the entities being measured (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 46-47). This method is independent to outliers and simple to perform and understand, but it is also impossible to draw any conclusion regarding the differences between the performances of entities (ibid.). The results of the method do not conclude if the resulting risk is high, middle or low but only focuses on the differences in performances between countries (Birkmann J. , 2007).
2. **Standardisation/z-scores:** The standardisation method converts indicators to a common scale by calculating the average and standard deviation for each indicator and then simply retracts the average for the indicator and divides with the standard deviation (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 47). This results in the common scale having an average of zero and a standard deviation of one (ibid.). The average of zero means that misrepresentations of aggregation are avoided (ibid.). Extreme values thus have a greater effect on the index and this might be desirable if the intention is to reward exceptional behaviour, *i.e.* if an extremely good result on a few indicators is thought to be better than a lot of average scores (ibid.). This effect can be corrected in the aggregation methodology by excluding the best and worst individual indicator scores by assigning differential weights based on the "desirability" of the individual indicator scores (ibid.).
3. **Min-max/Re-scaling:** The Min-Max or Re-scale method subtracts the minimum value from the indicator value and then divides this with the range of the indicator values (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 47-48). This results in an identical range for the indicators in the index (ibid.). The method can thus widen the range of indicators situated in a small interval and by that increasing the effect on the index explicitly, but extreme values or outliers can distort the indicators. This is the method used in the EER Index (ibid.).
4. **Distance to a reference:** This method measures the relative position of an indicator in comparison with a reference point (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 48-49). This reference point could be the average value, the maximum value, the minimum value, the indicator at a given time or any value that one wants to use as a benchmark (ibid.). The indicator is then given a score depending on its distance from the reference (ibid.). The problem with using maximum

respectively minimum values as reference points is that they could be unreliable outliers (ibid.).

5. **Categorical scale:** The Categorical scale normalisation appoints a score for each indicator that can either be qualitative (good, average or bad) or numerical (one, two or three stars) (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 49). The scores are often based on percentiles of the distribution such as the top 5 % receiving a score of 100 (ibid.). If the definition of the indicators changes over time, this will not affect the transformed indicator since the percentiles are still the same (ibid.). This normalisation is difficult to follow over time since it excludes large amount of information about variance between units (ibid.).
6. **Indicators above or below the mean:** This method transform the indicators so that the values around the mean receive a score of 0, whereas those above or below a fixed threshold receive 1 and -1 respectively (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 28; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 50-51). It is a simple method not affected by outliers but it omits information regarding how far from the threshold an indicator is and thus equalises all indicators receiving the same score (ibid.).
7. **Methods for cyclical indicators:** The economy fluctuates in production, trade and economic activities in general (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 29; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 51). This is called the business cycle and the result of surveys regarding this are often combined into indices in order to better predict these cycles and to reduce the risk of false signals (ibid.).
8. **Balance of opinions:** This method is a variant of methods for cyclical indicators (ibid.). For each indicator, managers of firms stemming from different sectors and of varying sizes of the firms are asked to express their opinion on their firm's performance. The indicator score varies between -100 and 100 where -100 equals all firms reporting deterioration and +100 if all firms have noted an improvement (ibid.).
9. **Percentage of annual differences over consecutive years:** This method, as the name suggests, represent the percentage growth with respect to the previous year instead of the absolute level (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 29; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 51-52). It can only be used if data are available for a number of years (ibid.).

F. WEIGHTING METHODS

The predominately chosen weighting method is **equal weighting (EW)** where all the indicators are given the same weight (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 31-32). This method is often used when there are no statistical or empirical reasons for using another method, when enough is not known about the indicators' relationship or when consensus of an alternative cannot be reached (Jacobs, Smith, & Goddard, 2004, p. 46; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 31; Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 55). A problem with using equal weighting may be the presence of double counting caused by combining components with a high degree of correlation into one (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 55; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 32). By testing for correlation this can be adjusted by only choosing the indicators with a low degree of correlation but a threshold of what level of correlation would imply double counting is needed, since there will be some positive correlation between different measures of the same aggregate (ibid.). Minimising the number of indicators in the index could also be of use for other reasons such as transparency and parsimony (ibid.).

Some methods of weighting are based on statistical models such as **principal components analysis (PCA)** combined with factor **analysis (FA)**, **benefit of the doubt (BOD)** and the **unobserved components model (UCM)** (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 32).

For the PCA and FA methods the indicators are grouped together according to their degree of correlation and the first step is thus to analyse the correlation of the data with a multivariate analysis (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 56-58; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 32, 63-72; Jacobs, Smith, & Goddard, 2004, p. 46). If the degree of correlation between the indicators is low it is unlikely that they share common factors and if no correlation exists, weights cannot be assigned (ibid.). The idea of this combined method of PCA and FA is to generate the highest possible variation in the index by using the smallest possible number of factors so that the index captures as much as possible of the information common to the indicators (ibid.). The indicators need to have the same unit of measurement (ibid.). This method does not use weighting as a measure of theoretical importance of an indicator but for correction of overlapping information between the correlated indicators (ibid.). Although this method solves the problem with double counting it has in turn problems with estimation of data such as it being sensitive to modifications of the data and to the presence of outliers (ibid.).

The BOD method assigns weights according to the ratio of a country's performance in relation to its benchmark and this means that it is sensitive to national priorities (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 59-63; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 92-94). The weights are also country specific and this means that a global comparison is impossible (ibid.). This method is useful since the weighting is not unfair since any other weighting method would generate lower scores. The best performer will however not see its progress reflected in the index (ibid.). This can of course be solved by using an external benchmark, but then this needs to reach consensus (ibid.).

UCM estimates the weights by the usage of a maximum likelihood method to obtain a function of the indicators (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 64-66; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 94-96). The indicators are estimated to depend on an unobserved variable and an error term (ibid.). The estimation of this unobserved variable will partly display the relationship between the index and its indicators and the weights are set to minimise the error in the index (ibid.). This method can be used even if the indicators are not correlated but if they are, the results are poor and thus the method is the most useful if all of the sub-indicators are independent (ibid.). To use this method a large amount of data is required and the reliability and robustness of the results depend on this (ibid.).

Other methods of weighting are based on a participatory approach and incorporate various stakeholders such as experts, the public and politicians (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, p. 31). These methods work best on a national level when there is a well-defined basis, on an international level the results could be contradictory (ibid.). Examples of these kinds of methods are the **budget allocation approach (BAP)**, **analytical hierarchy process (AHP)** and the **conjoint analysis (CA)** (ibid.).

In the BAP approach, experts on a given subject such as education or the environment, are asked to allocate a "budget" of one hundred points to the indicators and distribute the points among them, giving most points to those indicators they feel are the most important to stress according to their own experience and judgement (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, p. 100; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 66-68; Jacobs, Smith, & Goddard, 2004, p. 46). The weights are calculated as the average budgets (ibid.). An alternative to this method would be to ask the general public what their degree of concern is regarding certain issues related to the indicators, since it is more difficult to ask the public to allocate points on individual indicators (ibid.). These polls are easy to use, inexpensive to carry out and create consensus for policy actions (ibid.).

In AHP indicators are compared pair-wise by asking the participants two questions: 1. Which of the two is more important? 2. By how much (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 68-71; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 96-98)? The preference is expressed in a scale of 1 to 9 where 1 represents equal importance and 9 that one of the indicator is nine times more important than the other (ibid.). These results are then placed in a comparison matrix and the relative weights are calculated by an eigenvalue technique (ibid.). This method can be used for both qualitative and quantitative data and is transparent, but at the same time it demands a high amount of comparison and are dependent on who the participants are (ibid.).

The idea of CA is to generate the effective "willingness to pay" by asking participants how important they think an individual indicator is (Nardo (b.), Saisana, Saltelli, & Tarantola, 2005, pp. 71-72; Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 98-99). A number of scenarios containing different sets of values of the indicators are set up and participants are then asked to evaluate them and choose which of these they prefer (ibid.). The method is statistically based but it relies on the participants and the results of the rankings will give the weights (ibid.). The main weaknesses are the large sample of participants needed and that the process of estimation in itself is complex (ibid.).

The choice of weighting method will affect which aggregation method can be used (Nardo (a.), Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008, pp. 32-33). The linear aggregation is useful when the indicators have the same measurement unit if the mathematical properties are taken into consideration (ibid.). Geometric aggregations are to be used if some degree of compensability between the indicators is wanted (ibid.). Linear aggregation reward indicators proportionally to the weights while geometric aggregations reward the countries with higher scores (ibid.).

G. INTERVIEW QUESTIONS AND ANSWERS

Based on your own work experience, which incidents were you involved in that you would classify as an environmental emergency? (If several, which ones in particular stand out? Why?)

In general, the opinion of environmental emergencies is more or less the same amongst the interviewees. Natural hazards such as typhoons, earthquakes, floods are the dominating incidents mentioned, but also pollution incidents such as oil spills, industrial pollutions, and volcano outbreaks are common. When talking about the specific regional emergencies the emergencies in ROCCA are derived from floods, earthquakes, wildfires and a tough winter climate. In this region there are many unsafe storage sites of uranium, pesticides and other types of toxic substances that will affect the region if they are struck by a natural hazard. In ROSA the experiences of environmental emergencies are also dominated by natural hazards such as floods and earthquakes. In ROAP natural hazards is dominating in combination with lack of knowledge on how to deal with the aftermath.

According to the interviewees, the level of impact of these incidents is determined and affected by several factors such as the scale of the incident, the location of the incident and the vulnerability of the people and infrastructure in that area. For instance, the impact of an earthquake in Indonesia, a more developed country, can be high because of the infrastructure and population density at the same time as a flood in a rural area in Mozambique also can have a high impact due to the level of development in the region. A majority of the interviewees expresses that incidents stand out as the combination of severity and long term impact on the environment after it has occurred. It is not the hazard and its magnitude in itself that makes the difference, but instead how vulnerable the community where it strikes is.

What, in your opinion, constitutes an environmental emergency?

The opinions of the interviewees regarding this are different in terms of the views on direct and secondary impacts, linkages between hazards, vulnerability and capacities and the long term aspect of a hazard. An environmental emergency is most often expressed by the interviewees as a sudden on-set natural hazard that has a (secondary) effect on people, infrastructure and the environment. The secondary effect could be that the natural hazard triggers a technological hazard that in turn triggers the emergency, but it also location, population and capacity dependent. The interviewees also note that the impact on people is linked with the capacity of the community to respond but also the scale of the incident.

There are differences expressed amongst the interviewees regarding whether an environmental emergency would have to affect people or not, or if an environmental emergency could be triggered by manmade technological disasters directly. For example, if an oil spill occurs in Siberia, a low populated area, is it an environmental emergency or not? The oil is still present and greatly affects the ecosystems, but not many people will be affected by the event. One interviewee expresses that an environmental emergency is the “interaction between the natural disaster and the manmade infrastructure”, meaning that an emergency cannot occur without any of these. Some of the interviewees state that the mandate or the line of work is what limits the people’s view of the definition. Since we are dealing with this issue from a human development point of view, the impact on a community and their livelihoods is what is important, not only the preservation of the environment.

The JEU works by the UNEP definition where an environmental emergency is defined as:

"a sudden onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that cause or threaten to cause severe environmental damage as well as harm to human health and/or livelihoods"

How well do you think this definition correlates with you own perception of what an environmental emergency is?

Disclaimer: This question was only asked with the interviewees at the different regional offices to get an overview of how aligned they are with the JEU office in Geneva.

Three out of five interviewees from the regional offices do not particularly find this definition optimal. It is perceived as to generic, long and broad and the sudden onset-part is considered an issue as the interviewees feel that it is difficult to determine what a sudden onset is and what a slow onset is. A hazardous event might not have immediate impact on the environment, human lives and livelihoods, but it could have a long term effect and this long term effect was thought to be hard to interpret within the definition of an environmental emergency according to these interviewees.

The context of the definition is linked with technological and industrial hazards, according to one of the interviewees who feel that environmental issues should be integrated into any kind of emergency instead of being treated as an own entity since the risk of environmental disaster is presence whenever any kind of disaster occurs. Other interviewees feel that the concept of capacity to respond should be integrate into the definition since it is currently perceived to be absent.

In your opinion, which type of hazards cause environmental emergencies?

- **a) Considering the proposed hazards, which one would you give higher priority?**
- **b) Why?**

The interviewees from JEU and CADRI mention natural hazards such as earthquakes, floods, landslides and tsunamis and manmade hazards such as chemicals, transports, fires, conflict, explosions, oil spills and infrastructure failure. When asked which of these they would prioritise, three out of six chose natural hazards and another set of three out of six chose industrialisation or industries[12]. The natural hazards are considered important since large

[12] Authors' remark: There seems to be confusion regarding the use of words. Some mention industrialisation as a hazard while other's mention industries themselves and their characteristics, their location and poor urban planning as the main hazards related to industries. Essentially, these words are all related to the same kinds of events.

scale natural hazards affect many people and the aftermath results in a lot of disaster waste. The process of industrialisation/industries and urbanisation is heavily linked with the presence of environmental emergencies according to the interviewees. The rapid urbanisation has resulted in cities absorbing industrial areas meaning that the technological hazards have been relocated to where people live. For instance, there was an explosion in an ammunitions depot in Brazzaville, Congo, a couple of years ago. Today, that depot is located within a community and if that explosion were to occur today, the consequences might be devastating. One interviewee states that the more developed a country becomes, the more the risk of environmental emergencies. Many countries also lack urban planning and safety training which will also increase the risks. Industrial disaster risks are hard to predict since there is not enough data on how these disasters are happening and they are often smaller in scale. The interviewees feel that the importance of a hazard is dependent on human impact, economic impact and the frequency of the hazard and there is thus a need for study on this subject.

One of the interviewees also states that protracted crises or conflicts do have environmental impact, but are not environmental emergencies per se. For instance, a conflict could lead to mass displacement of people which could lead to an increase of pollution, deforestation, erosion and environmental degradation and further spark the tensions within a community.

According to the interviewee from ROAP any disaster is thought to have the potential to cause environmental damage but natural disasters like floods in urban areas, volcanoes and tsunamis are mentioned. For instance, in 2011, flooding occurred across Thailand where the environmental impact derived from water purification plants being contaminated. This lead to people not getting access to water unless they could buy bottled water which in turn could not be produced because those factories were contaminated. The floods could also have led to leakage of other toxic substances such as oil spills.

In ROCCA, the interviewees also mention natural hazards and technological hazards but the majority put more emphasis on technological hazards. The hazards mentioned are floods, earthquakes, wildfires and nuclear hazards. The floods and landslides affect the unsafe storage facilities of uranium, pesticides and other toxic species, since they move these hazardous compounds around. According to one of the interviewees, frequently occurring intense rainfall events triggers both flash floods and landslides which can combine and turn into a mudflow. The climate change will make these hazards more frequent. Another interviewee states that the technological hazards are important since the compounds being released are not natural to the environment and it will be very difficult for the environment to cope with this kind of exposure. A third interviewee says that wildfires are also considered to be important, even if they do not necessarily affect that many people, since there are more room for preventing them and if a fire would occur in the Chernobyl affected zone, where the trees are polluted with radioactive emissions, then the cloud could potentially spread across a large area and affect a lot more people. There are also currently no established plans on how to address this issue according to said interviewee.

The interviewee from ROSA mentions natural hazards, including climate change, to be the hazards having impact on the environment. Earthquakes, floods, climate change and urbanisation (if considered a hazard) are the most important hazards to consider. Earthquakes, floods and landslides are being prioritised because of the major impact on infrastructure they have. Climate change is an important issue because the climate is change faster that industries are. For instance, if industries used to clean their channels from toxic waste before the rain season and the rain season is changing; toxic waste might be leaked into the surroundings. The rapid pace of urbanisation results in industrial areas becoming part of the urban cities and with this the risks are increasing. This view is also consistent with the opinions from JEU and CADRI regarding the issue of industrialisation/industries.

What vulnerabilities in relation to environmental emergencies are important to consider?

a) **Considering proposed vulnerabilities, which one would you give higher priority?**
b) **Why?**

One of the interviewees expresses that the impact of a hazard to a community is due to the vulnerability of that community. To manage disasters, one should not look at the hazard and its size, but rather at the magnitude of the vulnerabilities of said community and how they affect people. Vulnerability is a wide concept lacking a commonly accepted definition (Birkmann J. , 2007, p. 21; Barnett, Lambert, & Fry, 2008, pp. 103-104). This is made visible in the answers that were presented to this question where the opinions differ from one another. One of the interviewees expressed this as "it depends on how you define vulnerability. Environmental people put exposure into the vulnerability side of the equation. The natural disaster people put exposure on the hazard side."

Three of the interviewees from JEU and CADRI mentioned the dependency on the environment for livelihood as significant vulnerability. For instance, rural or indigenous communities are more dependent than others on the environment which will lead to them being more affected by an environmental emergency. Other vulnerabilities mentioned are poverty and/or low income, lack of education, lack of access to public health, lack of access to drinking water, lack of knowledge, information, analytical skills and/or tools in terms of addressing environmental problems as well as insufficient infrastructure. For one of the interviewees the geographic location, the level of environmental degradation and the proximity to hazardous industries were considered vulnerabilities and what to target when dealing with environmental emergencies. Another of the interviewees did not agree upon the vulnerabilities expressed in the initial version of the EER Index and thought that they were more receptors of an emergency than actual vulnerabilities. Instead, this interviewee expressed that vulnerabilities are to be viewed as the lack of knowledge and the capacity to cope and respond.

Vulnerabilities are linked with exposure to poverty, greed and corruption according to the interviewee from ROAP. These components expose people and those people are the least empowered, living on the margins close to chemical factories, coast lines, landslide prone areas and near waste dump sites. In general, the vulnerabilities can be categorised under the geographic resources and the lack of different capacities.

The interviewees for ROCCA mention quite different things. Two out of three mention the dependency on the environment for livelihood, poverty and/or lack of income, geographic location, the weakness of infrastructure as well as the capacity to cope with the problems that arise in the region. One of the interviewees explains that the majority of the population in this region is living in rural areas and their main employment is agriculture. When a disaster occurs the people do not have any other source of income or means. To manage the risks it is important for the farmers to diversify production and their source of income, but since the region has deliberately been formed to support a monoculture of cotton they will not be enabled to do so. In some countries, the farms are also supported by the state and for example in Uzbekistan, the state controls 80 per cent of what you grow, which means that they tell you where and what you are supposed to grow as well as how much you are supposed to deliver. Other vulnerabilities in the region that were mentioned by the interviewees individually are the weakness of the healthcare, land use (in terms of usage, allocation and tenure), lack of knowledge as well as the weak polices and enforcement of these. One of the interviewees is firm in their statement that exposure should be grouped together with hazards and not vulnerabilities, meaning that location of settlements, for example, is not a vulnerability but an exposure while the another one of the interviewees views exposure towards natural hazards and population density as vulnerabilities.

In ROSA, the vulnerabilities are linked with poverty, disasters, man-made crises and conflicts according to the interviewees. The main vulnerabilities are livelihood dependency on the environment, poverty and/or lack of money and malnourishment.

The question of prioritisation is debatable. Four out the 11 people interviewed suggest you cannot rank one kind of vulnerability over the other since they are all equally important. According to the interviewees, vulnerabilities are linked with human rights and no one can be considered as more important than the other. Comparing vulnerabilities would be like trying to compare apples with oranges. When investing, one should aspire for an even distribution of the resources. The other group of the interviewees has pinpointed the most important vulnerabilities as structural in terms of deteriorated infrastructure, the dependency on the environment for livelihoods, any type of socioeconomic vulnerability such as income, food and drinking water as well as the geographic location.

How do you experience the prioritisation of capacity development interventions?

- **a) In your opinion, what factors should be considered?**
- **b) Why?**

The interviewees from JEU state that they have a portfolio divided between response to and preparedness for environmental emergencies. To decide the prioritisation and where to invest both, in terms of resources and time, there is a need for several things. The interviewees describe that the first step is to analyse the situation or region to figure out why disasters are happening and why a region or country is vulnerable. To do this, interviewees suggest that one could use environmental impact assessments or regional workshops, focusing on points such as land use planning, law enforcement (good for keeping safety and environmental standards, overseeing industries, etcetera), resources and capacity available, population density as well as governance to single out priorities and thus the vulnerable countries or regions. After that, it is important to look within the organisation to see if it actually possesses the competences needed and if a project is feasible to do. The EER Index is welcomed by the interviewees, because it will aid in prioritisation of regions and since the resources are limited this will make their work more efficient.

The interviewee from CADRI states that they deal mostly with institutional capacity development, meaning that they help countries strengthen the way they handle disaster prevention and preparedness at an institutional level. The organisation contributes with their competences and people in place which have technical knowledge of doing disaster prevention and preparedness, while the countries contribute with their equipment and financial support. The most important part with capacity development is the ownership the beneficiary has in terms of the capacity development support they receive and how they extend that support.

The problems with prioritisations are more focused on the coordination between the different organisations operating in the region, than with the actual prioritisation between countries and what factors to consider, according to the interviewee from ROAP. The incentives for organisations are usually along their mandate lines. Other challenges, according to the interviewee, are that many organisations are experiencing some difficulties regarding cooperation and communication with each other which could unfortunately result in work being duplicated and unnecessary. To increase the efficiency, the interviewee suggests more focus on communication and cooperation earlier in the work process before even considering what factors is important in the prioritisation process. Another important thing is coherence of what countries and regions in the countries really need.

In ROCCA, two of the three interviewees felt that they could answer this question and these interviewees' opinions are by and large aligned with some minor differences in show detailed their answer were on this subject. The interviewees feel that there are different factors deciding the prioritisation depending on what kind of aim the capacity development possesses. First, like at the JEU, a risk assessment should be performed in order to gain understanding of the risks in the region. The risk assessment is based on exposure to natural hazards, socioeconomic status and the capacity of the government to respond. The capacity of the government is considered to be most important factor since a country might be prone to natural hazards but still be able to cope with them themselves according to the interviewees. After this, the rest is a combination of what the national partner is willing or able to do and what is actually feasible to do.

The interviewee from ROSA works with this according to three bullet points, the first one being mapping of the hazards in the region and their severity and the second one being mapping of the level of vulnerabilities such as poverty, prevalence to malaria and other diseases and malnourishment. The third point is also considered the most important, and that is the mapping of the level of the current capacities.

Focusing on the regions Asia and the Pacific, Caucasus and Central Asia and Southern Africa, which three countries would you rank as most prone to environmental emergencies?

a) Why?

Disclaimer: This question was divided into two aspects, one being "Where is the risk?" and the other being "Whom would ask for/need assistance in case of an emergency?" where most of the interviewees answered the question with focus on international assistance, whereas some answered on the other or both aspects.

In the Asia and the Pacific region, Indonesia, China and India are mentioned by four out seven interviewees. The other interviewees mention one or two of these countries as the most prone to environmental emergencies. The top three ranked countries in the EER Index are East Timor, Cambodia and Papua New Guinea.

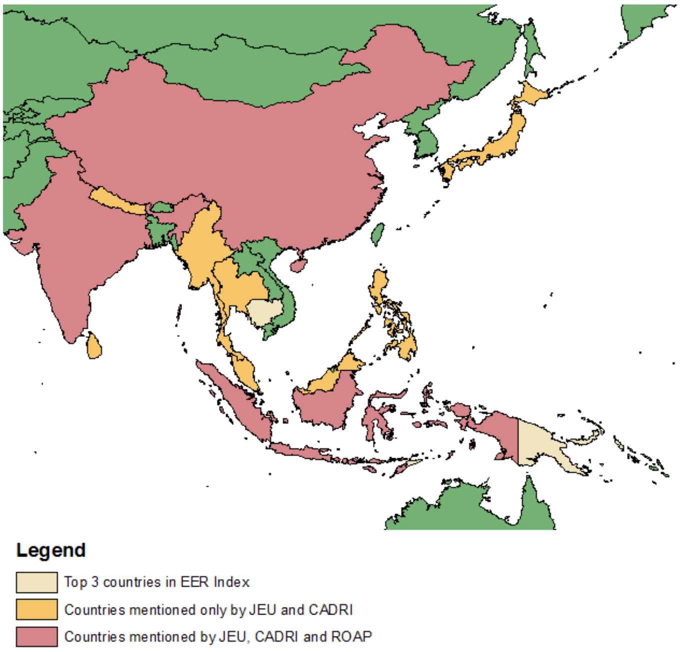

Figure 6 The countries mentioned in the region of ROAP.

China and India are thought by the interviewees to possess good governance capacities, but they are at the same time dealing with fast industrialisation and urbanisation processes coupled together with large populations and being situated in a natural hazard prone area. In Indonesia and India, a big part of the population is also living on the margins.

In the region of Caucasus and Central Asia eight out of nine interviewed mention Tajikistan and four of out of nine mention Kyrgyzstan as countries prone to environmental emergencies. Armenia, Georgia and Kazakhstan are mentioned by three interviewees and out two of the three interviewees from the regional offices mention Fergana Valley, Turkmenistan and Uzbekistan. Mongolia, Moldova, Afghanistan and Pakistan are mentioned by one interviewee each. The top three ranked countries in the EER Index are Tajikistan Azerbaijan and Kyrgyzstan.

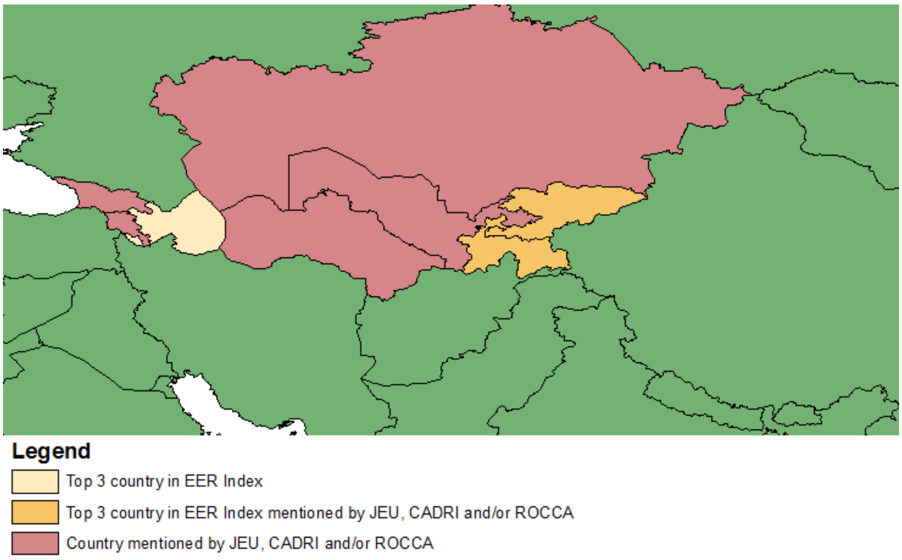

Figure 7 The countries mentioned in ROCCA.

In Tajikistan and Kyrgyzstan there are a lot of industrial legacy sites, poverty and the countries capacities' to cope are low according to the interviewees. The regional offices are more focused on the Fergana Valley than trying to pinpoint countries. The Fergana Valley is located partly in Uzbekistan, Kyrgyzstan and Tajikistan. It is a very densely populated area with a lot of different ethnicities and because of it being a border area there are issues with border demarcation and conflicts over land ownership according to the interviewees. In this area, the water sources are scarce, there are energy conflicts and it is also a natural disaster prone area frequently struck by earthquakes, floods and mudflows which combined with the unsafe uranium and pesticides storage sites makes it the top priority area.

In the region of Southern Africa, six out of seven interviewees mention Madagascar while four out of seven mention Mozambique. Angola is mentioned by two of the interviewees and South Africa, the Seychelles and Malawi are mentioned by one interviewee each. The top three ranked countries in the EER Index are Mozambique, Angola and Zimbabwe.

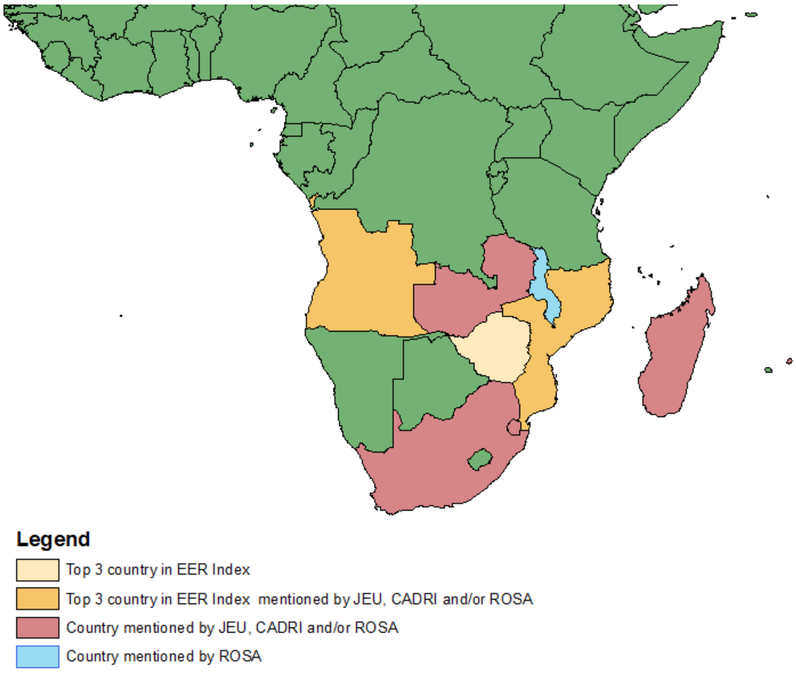

Figure 8 The countries mentioned in ROSA.

The interviewees states that, in this region, the development process of industries in combination with bad governance and low capacities to cope is what makes the countries prone to environmental emergencies. In Madagascar there are also a lot of mining industries while in Mozambique and Angola oil and gas exploration are dominating and this are factors of proneness. Madagascar and Mozambique are additionally frequently affected with cyclones.

What tools are you currently using for evaluating environmental risks?

a) **What are the strengths and weaknesses of these tools? Motivate.**
b) **If no: why not? (Suggestions: lack of tools, lack of time, lack of knowledge…)**
   If no: should such a tool be available, would you be interested in applying it in your region/globally?

The opinions regarding the usage of tools differ at the JEU. Some say that they have not been using any evaluating tool while others say they have. Currently, JEU are using or are supposed to use the EER Index according to the interviewees. Before that, the evaluations rendered consisted of requests from regional offices, proxy indicators from the GFM and the forthcoming InfoRM. If they received a request from a country, they would, according to the interviewees, combine baseline assessments, literature studies, disaster assessment reports, risk reports and the Hyogo Framework for Action to evaluate the risks. When evaluating a country, one should for example look for the number of industries and legacy sites in the country as well as its intrinsic capacities.

The weaknesses, according to the interviewees, with using this methodology are that they are not possible to perform in every country, that they are proxy tools that do not measure exactly what is needed as well as that they are not taking into consideration vulnerabilities and capacities. The weakness with the EER Index and every other index is that climate change has not been taken and it will exacerbate certain risks and effects in terms of increased extreme weather events and this will in turn affect the vulnerabilities of communities.

The ones that answered that they did not use any tools expressed the opinion that it was due to the shift in mandate from response to both response and preparedness within the JEU and not really being involved in that yet. One interviewee was concerned about the situation that could occur if they decide to focus on the top 20 countries most at risk, how should they handle the situation when country number 40 asks for assistance?

OCHA ROCCA has developed their own vulnerability analysis that they are using, according to the interviewee and are currently waiting for the InfoRM so that they can adapt it to a lower administrative level and try to collect the same sort of data from each province in the countries they are working in. They have also developed early warning analyses for the region and combined with operational information from UN agencies and external sources, statistics as well as hydrological and climate forecasts they are able to predict the situation in the region for the coming months and can thus focus their attention to support timely and predictable mitigation measures.

The weaknesses with these methods are that the vulnerability analysis is not that comprehensive and scientifically valid and that the early warning analysis is time consuming and the report might already be out-dated by the time it is completed.

UNDP RBEC is not using any tools for this since they just recently got mandated to do so according to the interviewee. They would welcome an index for this since it would save them a lot of time.

The interviewee from UNEP ROE states that they are conducting regional environmental security risk assessments which are performed at different levels and institutions. Firstly, a desk assessment is performed which is based on existing resources, statistics and scenarios and where UNEP ROE analyse what the environmental security risk could be. Security risk in this context is both the natural and man-made disasters as well a conflict risks. In the next phase of the work process national consultations are organised where representatives of ministries, such as environment, foreign affairs, agriculture and forestry and representatives of civil societies through NGOs are cooperating in order to review the desk assessment and then report back their priorities to UNEP ROE. After that, the same assignment is performed at a regional level where representatives from different countries in the region are invited in order to reduce the transnational risks and reach consensus on priorities. The outcome of the assessments coupled together with results derived from field missions in order to assess the risks ends in an assessment report. This report often contains a priority list of thing that should be addressed and these are then used in the next phase of the process which is the design of projects.

The strengths of this way of working are the consultation process where UNEP ROE brings in national ownership by involving countries in the process, but at the same time work on the regional level. The weakness is the flip side of the coin, it could lead to time delays in the process because of countries having to endorse their work and agree upon the priorities.

The interviewee from OCHA ROSA states that the organisation has environmental risk integrated into their general assessment tool. This tool is in the form of a questionnaire with some of the questions linked to environmental issues. If these questions were not included the assessment would not get the right context.

OCHA ROAP is currently only using GFM for evaluating disaster risk according to the interviewee, but this index does not contain a specific environmental component. The reason for not using any other evaluation tools is that they have not really drilled down the level of precision of their work in preparedness and response yet. *"An environmental emergency generally isn't just an environmental emergency; it's an emergency with an environmental element to it."* If an event occurs and the government gives approval, an UNDAC team is generally send out to help with the response and OCHA ROAP wants someone from the team to have an environmental background in order to examine the environmental consequences of the disaster.

The strength of using GFM is that it was developed in the Asia/Pacific region with staff from the region. The index is the best that they have got for now and is used as a prioritising tool for resources.

For what purposes would you use an environmental emergency risk index? (Suggestions: programming, analysis, information sharing, strategic decision making)

There are a lot of purposes for the tools and the interviewees mentioned the following purposes: for programming, for analytical purposes, for the baseline, for collecting more information on capacities and different hazard elements, for advocacy purposes, for raising awareness, for prioritisation, for better preparedness for environmental emergencies, for monitoring early warning information, for communication and discussing within the organisation, with donors and with countries requesting helps.

A food for thought regarding the launching of an index is how the reception of the EER Index from the countries will be. One of the interviewees states that *"we like to rank others but we do not like to rank ourselves"* and stresses the importance of carefulness about what the tool can and cannot do and what the impact of it will be.

What would be the added value of an environmental emergency risk index?

The interviewees from JEU feel that with this index, attention will be paid to addressing environmental emergencies and to emphasise the role of environment in disaster response. The index will aid in identifying the countries that are most at risk and thus also where to focus the resources in terms such as capacity development, staff and funding. It is also possible to break down the components to know what sort of capacity building is needed in the country or region. The credibility of funding will be increased and this will affect the donors and the rest of the humanitarian community. The index will make the organisation more cost-beneficiary since the resources will not be invested randomly but in the place where the highest return is achieved.

The interviewee from CADRI views the index as a helpful complementary to other, existing index. The index is thought to integrate different sectorial elements of disaster risk together which will make disaster risk management more efficient. Disaster risk management is not consisting of only one dimension and can thus not be conducted by one sector. Understanding of every component is needed in order to perform efficiently.

The interviewee from OCHA ROCCA emphasises that the index is needed since it currently does not exist anything specific on environmental risks. Since the index is more scientifically valid than the tools they are currently using within the organisation they will be able to use the index to develop their own version with applicable indicators for the region and with regional data.

For the interviewee from UNDP RBEC the added value will be a quick and easy shortcut to feed into the decision making of the people lacking the expertise and competence in this area.

The UNEP ROE interviewee believes that the added value will be communication being made quicker and easier, especially for decision makers who do not have much time to read a lot of material and are also keen on using aggregated material. It will also be possible to compare the situation in different countries and locations and facilitate the decision making.

The OCHA ROSA interviewee mentions that, just as the JEU interviewees, the EER Index will bring awareness of possible risks and aid in the prioritising of countries.

The interviewee from OCHA ROAP believes that the added value would be the extra aspect that could improve decision making. In this region, GFM is used to plan resources and with this extra environmental context, the prioritisation process would be skewed and that might enable a more realistic placement of resources.

Do you think there are any national data sets that contain information statistics regarding hazards, vulnerabilities and capacities? (Transport of hazardous materials, etc.)

a) **If yes: Would you have access to these kinds of data sets?**
b) **If no: How difficult do you think it would be to construct such collecting of data in your specific region? Are there any specific problems or obstacles as you see it?**

Disclaimer: This question was only asked with the interviewees at the different regional offices to get an overview of how aligned they are with the JEU and CADRI.

In ROAP the interviewee states that there are data sets but to be able to collect them one needs to conduct meeting with the national statistical offices (NSO) and explain why the data is needed and what it is going to be used for. Some governments can then see the added value of providing the data, while others cannot. The subject of collecting data for environmental risk is, however, a completely different story since these kinds of data is often very politically tied.

The OCHA ROCCA interviewee states that it is not easy to collect direct information from government because they are not willing to share their information. Instead, OCHA ROCCA works with different UN agencies and other organisations to do their own data collection. The major problems with this are that it is time consuming as well as impossible to collect data for all countries in the region and for all datasets. The interviewee from UNDP RBEC agrees upon the problem with willingness of the governments to provide data and adds that the data that exists is not always the data that you want and useful for what you are trying to measure. The UNEP ROE interviewee also agrees and states that this is for example illustrated in the archives being manually handled on purpose and that technology such as satellite imagery could help in mapping where industrial site are located but there is still an issue on knowing what they contain.

In ROSA there are national databases in most of the countries but the quality and size varies since they are newly established, according to the interviewee. The availability of data is connected to the sovereignty of states and the specific access to hazard data is limited since all do not measure all kinds of hazards. Hazards like military locations or location of industries, nuclear, and weapons storage are not information that most countries are willing to share.

Based on your experience, what lessons have you learned in developing national capacity?

Disclaimer: This question was only asked with the interviewee from CADRI to get an insight in lessons learned regarding national capacity development.

The first lesson learned is the importance of national ownership in terms of sensitising the governmental institutions into the connotation of taking into account disaster risk, preparedness and prevention in their line of work. The governmental partners need to see their responsibility in looking at vulnerabilities and risks that their population are exposed to.

A second lesson learned is that sometimes the governmental and the international cooperation partners (UN, different donors) are not working together and also that the different governmental partners might not be cooperating fully. This means, for example, that even though disaster risk is a cross cutting menace it does not mean that the ministry of agriculture is willing to develop a project together with the ministry of environment.

The third lesson learned regarding capacity development is the requirement of involving the civil societies in the projects and not only the institutions. Capacity development is not only about the different structures of governments but also about how individuals are able to make decisions themselves that will have an impact on their lives.

H. RESPONSE FREQUENCIES

In tables 4 and 5 below the answers from the interviews can be visualised with respect to number of answers within a certain domain of risk.

Table 4 All hazards that were mentioned. The number indicates how many interviewees mentioned it.

Type of hazards		JEU	CADRI	ROAP	ROCCA	ROSA	Sum:
NATURAL HAZARDS	Earthquakes	2	1		2	1	6
	Floods	2	1	1	2	1	7
	Landslides	1			2	1	4
	Tsunamis		1	1			2
	Volcanoes			1			1
	Extreme weather events	1			2		3
MANMADE HAZARDS	Industrial facilities/Chemicals	4			2		6
	Transport	1					1
	Fires	1			1 (wildfires)		2
	Conflict	3					3
	Explosions				1		1
	Oil spills	2	1	1	1		5
	Infrastructure failure		1				1
	Nuclear hazard				1		1
	Urbanisation					1	1
	Industrial facilities	1					1
	Land use planning	1					1
	Overpopulation	1					1
OTHER	Climate change	1			2	1	4

Table 5 All vulnerabilities that were mentioned. The number indicates how many interviewees mentioned it.

Type of vulnerability/lack of capacity	JEU	CADRI	ROAP	ROCCA	ROSA	Sum:
Dependency on livelihood/Undiversified livelihoods	2			2	1	5
Poverty and/or low income	1	1	1	1	1	5
Lack of education		1				1
Lack of access to drinking water		1				1
Lack of knowledge, information, analytical skills and/or tools in terms of addressing environmental problems/Weak policies and enforcement of these	3			2		5
Lack of coping capacity	2			2		4
Geographic location	1		1	2		5
Proximity to hazardous installations	1		1			2
Insufficient infrastructure		1		2		3
Greed			1			1
“Bad” governance	1		1			2
Weak healthcare		1		1		2
Poor land use planning				1		1
Population density				1		1