Overview of updated indicators for the WorldRiskIndex 2016 and indicator sheets with specific information regarding all indicators used

1. Overview of updated indicators for 2016

Exposure

Indicator	Name	Source	Update for 2016
A	Earthquake	Preview database of UNEP Global Risk Data Platform	No
B	Cyclone	Preview database of UNEP Global Risk Data Platform	No
C	Floods	Preview database of UNEP Global Risk Data Platform	No
D	Droughts	Preview database of UNEP Global Risk Data Platform	No
E	Sea-level-rise	Center for International Earth Science Information Network (CIESIN) University of Kansas Center for Remote Sensing of Ice Sheets (CReSIS)	No

Susceptibility

Indicator	Name	Source	Update for 2016
A	Population with access to improved sanitation	WHO/UNICEF Joint Monitoring Programme and CIA Factbook	Yes
B	Population with access to an improved water	WHO/UNICEF Joint Monitoring Programme and CIA Factbook	Yes
C	Percentage of population undernourished	World Bank	Yes
D	Dependency ratio	(HDR 2013) World bank development indicators	Yes
E	Extreme poverty ($1.25 a day (PPP))	World Bank and HDR 2011	No
F	GDP per capita (PPP)	World Bank and CIA Factbook	Yes
G	GINI Index	World Bank and UNU WIDER	No

Coping Capacity

Indicator	Name	Source	Update for 2016
A	Corruption Perception Index	Transparency International	Yes
B	Failed States Index	Foreign Policy	Yes
C	Number of physicians per 10,000	WHO and World Bank	Yes
D	Number of hospital beds per 10,000	WHO and World Bank	No
E	Insurance coverage	Munich Re	No

Adaptive Capacity

Indicator	Name	Source	Update for 2016
A	Adult literacy rate	UNESCO and CIA Factbook	Yes
B	Combined gross enrolment ratio	UNESCO and Human Development Indicators	Yes
C	Gender parity in education	UNESCO	Yes
D	Women in national parliament	MDG Indicators	Yes
E	Ecosystem vitality: Water quantity	Environmental Performance Index	Yes
F	Ecosystem vitality: Biodiversity & Habitat	Environmental Performance Index	Yes
G	Ecosystem vitality: Forestry management	Environmental Performance Index	Yes
H	Ecosystem vitality: Agriculture	Environmental Performance Index	Yes
I	Per capita government expenditure on health	WHO	No
J	Life expectancy at birth	Human Development Indicators	Yes

K	Per capita private expenditure on health	WHO	No

Altogether: 5 new susceptibility, 3 coping capacity, 9, adaptive capacity, 17 indicators updated for 2016

2. Calculation and indicatorsheets for the WorldRiskIndex

Evaluation criteria and standards for indicators and the selection of relevant data sources

The development of an index that outlines risk on a global scale has to be based on quality or evaluation criteria that support the selection of sound indicators. For the WorldRiskIndex the respective indicator system – particularly for the national scale assessment - the following criteria are taken into consideration:
The indicators – particularly at the national level assessment - have to be

- indicators for exposure allowing for a certain comparison of very different hazard types;
- vulnerability and adaptation indicators of a generic nature, in order to be relevant for different hazards (multi-hazard perspective);
- analytically and statistically sound;
- reproducible (particularly global index); and
- appropriate in scope, in terms of the local level assessment.

Furthermore, the indicators should also consider major goals of this study and thus should be:

- understandable;
- easy to interpret; and
- comparable.

Additionally, local indicators and criteria should allow for the integration of context-specific problems, strategies and measures and consequently do not all require that the above-mentioned criteria are matched. In this context, and in order to communicate the complexity, the local indicator and criteria system can be divided into a) a core set of comparable indicators, such as extreme poverty, etc., and b) a context-specific set of indicators and criteria that allow integrating region- and local-specific features and characteristics.

Indicators used for the World Risk Index

This section deals with the description and the calculation of the indicators used within the WorldRiskIndex in order to capture aspects of hazard exposure, susceptibility, coping capacity and adaptation that means the proposed concept of the index and indicator system will be "filled" with selected indicators. The overview of the selected indicators' measurement and weighting, within the index system, is explained and outlined according to the four major factors or components: a) exposure, b) susceptibility, c) coping capacity and d) adaptation. In this context, each of the indicators represents features of one of the four factors explained separately in respective indicator sheets, which explain in detail the used indicators. After having explained each indicator, additional information is given regarding the methodology.

Calculation of Exposure

In order to calculate exposure to natural hazards at the national scale, several spatial data sources are needed such as information regarding the gridded population and frequency of each hazard and its spatial extent. Current datasets (EM-DAT, insurance data) often solely encompass the number of hazards and hazard events per country, while information on respective land area affected or exposed, as well as people exposed, is hard to grasp. To determine "exposure" more accurately at the national level, the calculation of the number of people exposed to hazards per country is required, which involves the consideration of land area exposed, hazard frequency, and population distribution.
An alternative and globally-available dataset generated by different UN agencies (UNEP, UNDP/BCPR (GRIP), UN/ISDR) and the World Bank - the PREVIEW Global Risk Data Platform – was used for this calculation. The PREVIEW platform is a multiple agency effort to share spatial data on global risk regarding natural hazards. Data obtained from PREVIEW represents an estimation of the annual exposure to the four selected hazards (earthquakes, tropical cyclones, floods and droughts); it thus comprises a probabilistic component on the frequency of the respective hazard and information on the population distribution based on the LandScanTM Global Population Database. It has to be stressed that these global data are based on model calculations and therefore the matter of uncertainty within the model calculation has to be taken into account.

For example hazards of great spatial extent attain relatively high values according to their potential to affect all people in the respective area. This does not necessarily entail that the hazards pose a real threat to the exposed. Especially the physical exposure to droughts per country is quite high due to the input parameters and assumptions made for the calculation. Compared to other hazards, droughts differ in terms of occurrence periods and the time-span of the event itself (Peduzzi et al. 2009).

A novelty of this concept is the integration of emerging risks of climate change such as sea level rise. Since no information about the physical exposure is available in the PREVIEW data platform, this information has to be derived from existing global datasets like the gridded population of the world and the exposed area due to a 1 m sea level rise scenario. The population data were gathered from UNEP Global Environmental Outlook (GEO) Data Portal (http://geodata.grid.unep.ch) whereas the information regarding the sea level rise scenarios were obtained from the University of Kansas Center for Remote Sensing of Ice Sheets (CReSIS) (https://www.cresis.ku.edu/data/sea-level-rise-maps). Overall, these two datasets allow for an estimation of people exposed to future sea level rise. It has to be denoted, however, that the indicator on population exposed to sea-level rise gives a measure on the proportion of population currently living in an area that would be affected by a 1 meter sea level rise. It is thus lacking the probabilistic component intrinsic to the other four hazards, estimating the annual exposure.

Overall, the development of the exposure index encompasses the following process chain that was implemented with GIS analyses:

1. For each hazard - except sea level rise - and for each country, the physical exposure, which is an expected average annual population (year of reference 2007) exposed, was derived by calculating the zonal statistic (sum of each raster values within the bounds of each zonal polygon) within each national level.
2. The population exposed by 1m sea level rise was calculated by extracting the exposed population information from the 1m inundation file and the population dataset.
3. The exposed population-per-hazard was summed up and divided by total population, in order to obtain one exposure index per country.

A limitation of the "exposure" component may result from the difficult comparability of creeping and sudden-onset hazards, in this case droughts and sea-level rise on the one hand and earthquakes, cyclones and floods on the other. Another limitation has to be mention regarding the different scales of the available data. Especially the calculation of the physical exposure due to sea level rise for small islands revealed the scale problematic and the accuracy of georeferencing of different global datasets (see figure 1). Figure 1 indicates that the sea level rise data, the state boundary data and the population data were not congruent so that there is a small mistake which leads for example to the underestimation of exposure in case of the Maldives and probably also other small islands.

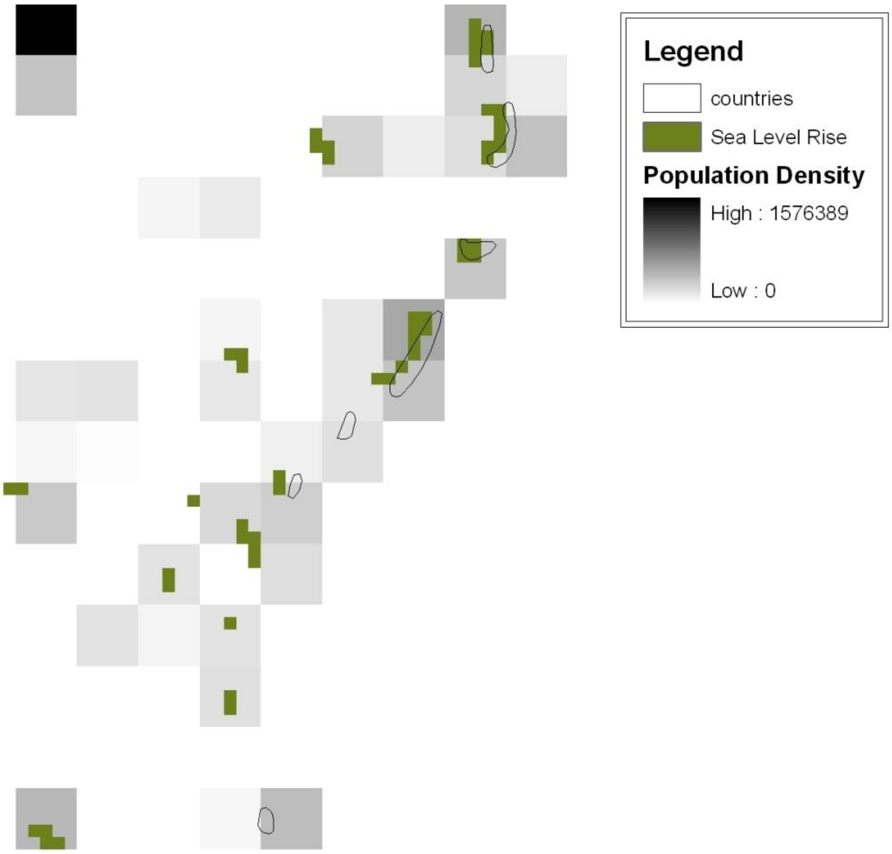

Fig. 1 Enlarged subset of the global datasets showing the problem of different scales and data accuracy.

<table>
<tr><td colspan="2">Exposure</td></tr>
<tr><td colspan="2">Indicator (1A-D)
Physical exposure to earthquakes, cyclones, floods and droughts</td></tr>
<tr><td>Measuring unit
Percentage of expected average annual population exposed to hazards per country</td><td>Spatial and temporal scale
national scale, based on population grids for the year 2010, provided by LandScanTM Global Population Database (30 arc second)</td></tr>
<tr><td colspan="2">Data sources
Preview database of UNEP Global Risk Data Platform (GRID) (http://preview.grid.unep.ch/)</td></tr>
<tr><td colspan="2">Relevancy of indicator
The exposure – measured as the total number of people exposed to the selected hazards (earthquakes, floods, droughts, cyclones) or rather the share of people exposed to a set of different hazards - is an important aspect for disaster risk. If not exposed, the country or population is not at risk.
The knowledge of the population exposed is fundamental for raising awareness and the development of protection measures (e.g. identification of suitable shelters) and evacuation strategies (e.g. development of evacuation routes). Additionally, the share of people exposed to a set of hazards on the total population also provides a first overview about one problem dimension, in terms of answering the question: how many people are exposed or might be at risk?</td></tr>
<tr><td colspan="2">Validity/limitations of indicator
The indicator is based on the estimated number of people exposed to hazards per year. It results from the combination of the (annual) frequency of hazards (ex-post focus) and the total population living in the spatial unit exposed for each event. It thus indicates how many people per year are at risk. The population data is based on the population of the world in 2007. The indicator is dependent on quality of population estimates and accuracy of frequency estimation of each hazardous event. (Peduzzi et al. 2009)</td></tr>
<tr><td colspan="2">Remarks:
The population exposed was calculated for all test countries and the results were compared with the corresponding risk profile on the prevention web (http://www.preventionweb.net/english/countries/statistics/risk.php?iso=deu).
The results were similar to the structure of exposure distribution defined within the maps of prevention web.</td></tr>
</table>

Exposure	
Indicator (*1E*) *Population exposed to sea level rise (possible from 1m to 6m)*	
Measuring unit *Percentage of population exposed to 1m sea level rise*	**Spatial and temporal scale** *national scale, based on Global Rural-Urban Mapping Project (GRUMP) consists of population for the year 2010* at a resolution of 30 arc-seconds (~1km)
Data sources GRUMP Population data:Columbia University, Center for International Earth Science Information Network (CIESIN) http://geodata.grid.unep.ch/mod_download/download.php Sea level rise from 1m to 6m: University of Kansas Center for Remote Sensing of Ice Sheets (CReSIS) https://www.cresis.ku.edu/data/sea-level-rise-maps	
Relevancy of indicator Sea level rise is clearly a major hazard for the future, in terms of further increase in the global mean temperature and impacts of climate change. Compared to floods or earthquakes, sea level rise is a creeping process that also implies irreversible changes. A population affected by floods might be able to return to the flood-prone area, areas covered by sea water will hardly be usable anymore for housing or agriculture. Sea level rise is considered a new hazard that particularly puts coastal populations at risk.	
Validity/limitations of indicator Population exposed to sea level rise is an important indicator for estimation of the impact climate change might have in the future. This indicator gives a general overview of people living within the most exposed (low-laying) areas such as coastal zones. It is desirable, however, to use more recent population estimates in combination with differentiated projections of sea level rise, in order to evaluate the severity of exposure with more precision. Including the projected changes it will also be possible to evaluate the time horizon of the extending exposure. No probabilistic component (annual exposure) available	
Remarks: The assessment of people exposed to sea level rise is possible using GIS analysis, but is rather time-intensive. Results are dependent on the available data, thus the problem of scale should always be kept in mind. The development of the exposure index encompasses the following process chain: For each hazard, except sea level rise, and for each country, the physical exposure - which is the expected average annual population (year of reference 2007) exposed - was derived by calculating the zonal statistic (sum of grid values within the bounds of each zonal polygon) within each national level. The population exposed by 1m sea level rise was calculated by extracting the exposed population information from the 1m inundation file and the population dataset. The exposed population per hazard was summed up and divided by total population, in order to obtain one exposure index per country.	

Calculation of Susceptibility

Susceptibility is calculated in several steps. Figure 2 gives an overview of different indicators within this factor and outlines the integration process of these indicators – including their weighting.

This sub-category consists of seven indicators, namely A) Population with access to improved sanitation (in %), B) Population using an improved water source (in %), C) Malnutrition (in %), D) Age dependency ratio, E) Extreme poverty, which is the percentage of population living on less than 1.25 USD/day, F) GDP per capita Purchasing Power Parties (PPP) and G) GINI Index.

Since the population with access to improved sanitation and population using an improved water source are "positive" characteristics of a community or society, the values had to be subtracted by 1 to receive the part of the population having no access to sanitation and improved water sources. That means the indicators were converted to the lack of access to sanitation and improved water sources, in order to follow the concept that susceptibility captures deficiencies.

Thereafter, each indicator was normalized and weighted equally, in order to aggregate the indicators.

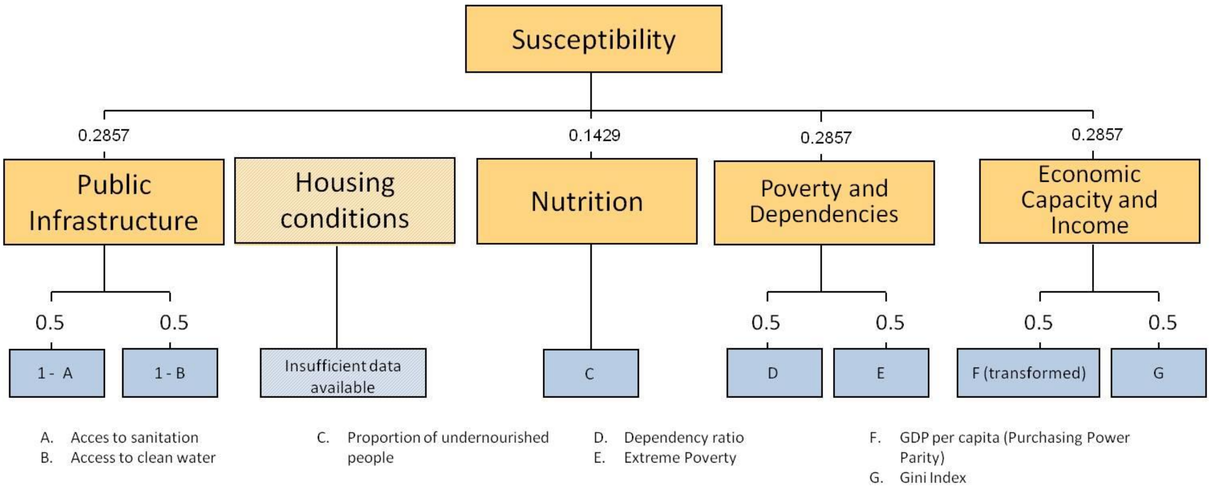

Fig. 2 shows the various indicators and weights for the aggregated index of susceptibility

Every indicator for susceptibility is shown in a respective indicator sheet

Susceptibility	
Indicator: A *Population with access to improved sanitation facilities*	
Measuring unit *Percentage of population without access (100-percentage value)*	**Spatial and temporal scale** *Country-based data for 210 countries*
Data sources WHO/UNICEF Joint Monitoring Programme (JMP) for Water supply and Sanitation: http://www.wssinfo.org/data-estimates/table/ World Bank data: http://data.worldbank.org/indicator/SH.STA.ACSN	
Periodicity of Data: JMP publishes updated estimates approximately every year	
Relevancy of indicator The population with access to improved sanitation facilities is an indicator of the quality of basic infrastructure, demonstrating quality-of-life and basic health condition of the population. Improved sanitation facilities comprise flush toilets, piped sewer systems, septic tanks, flush/pour flush to pit latrines, ventilated improved pit latrines, pit latrines with slab and composting toilets (see http://www.wssinfo.org/definitions-methods/watsan-categories/ for more detailed description). These facilities cannot only effectively prevent insect and animal contact, which are agents of diarrhoea, but also reduce other non-diarrhoea related health outcomes, such as scabies and helminthiasis (Esrey & Habicht 1986). In other words, improved sanitation should improve growth rates and reduce child mortality rates. In this context, it can be concluded that people without improved sanitation are susceptible to diseases and can become more vulnerable following a hazard. It has been identified as a key indicator of vulnerability at the national level by Brooks et al. 2005.	
Validity/limitations of indicator This indicator shows the percentage of the population with at least adequate excreta disposal facilities (private or shared, not including public).	
Remarks: Desegregation of data by urban/rural shows more significant variations	
Key Literature: Brooks et al. (2005); Esrey & Habicht (1986)	

Susceptibility	
Indicator: B *Population with access to an improved water source*	
Measuring unit *Percentage of population without access*	**Spatial and temporal scale** *Country-based data for 210 countries*
Data sources WHO/UNICEF Joint Monitoring Programme (JMP) for Water supply and Sanitation: http://www.wssinfo.org/data-estimates/table/ World Bank data: http://data.worldbank.org/indicator/SH.H2O.SAFE.ZS	
Periodicity of Data: JMP publishes updated estimates approximately every year	
Relevancy of indicator The indicator defines the percentage of population with reasonable access (within one km) to an adequate amount of water (20 litres per person) through a household connection, public standpipe well or spring, or rain water system (ADB 2004; http://www.wssinfo.org/definitions-methods/watsan-categories/). Unsafe or unimproved water (sources include among others: vendors, tanker trucks and unprotected wells and springs) is one direct cause of many diseases. In other words, people without improved water sources are vulnerable to diseases caused by unclean water and could become more vulnerable in the aftermath of a hazard, due to their existing ailments. However, improved water sources (based on the assumption they are likely to provide safer water) can significantly lower the risk of water-borne diseases, which, in turn, has in its turn a positive impact on people's health status (Esrey & Habicht 1986). Therefore, this variable is recognised as an important indicator for susceptibility to harm from natural hazards by different authors (e.g. Brooks et al. 2005; Bollin & Hidajat 2006)	
Validity/limitations of indicator This indicator shows the percentage of population with reasonable access to a certain amount of water. On the national scale, it can be used as an overall proxy for the general quality of infrastructure and health status. The indicator does not consider traditional water harvesting techniques that may play a major role in some (especially developing) countries which would overrate the susceptibility in this aspect.	
Remarks: Desegregation of data by urban/rural shows more significant variations	
Key literature: ADB (2004); Bollin & Hidajat (2006); Brooks et al. (2005); Esrey & Habicht (1986)	

Susceptibility	
Indicator: ***3*** *Percentage of population undernourished*	
Measuring unit *Percentage*	**Spatial and temporal scale** *Country-based data for 214 countries*
Data sources World Bank data, World Development Indicators: http://data.worldbank.org/indicator/SN.ITK.DEFC.ZS	
Periodicity of Data: annually	
Relevancy of indicator Malnutrition in this case is represented by proportion of population below the minimum level of dietary energy consumption. The indicator illustrates the problems of food insecurity and hunger of a population, which has serious consequences on people's physical condition and health and very negative impacts on the mental and physical development of children (cf. Von Grebmer et al. 2010; UNSCN 2009). Malnutrition situation can be also a product of different circumstances having relationship with development policies and strategies, such as agricultural measures for food availability.	
Validity/limitations of indicator The prevalence of undernourishment is calculated using estimations on food available (production, trade), inequality in accessibility of food (household income) and the minimum dietary energy requirement. $P(U) = P(x < r_L) = \int_{x<r_L} f(x)\,dx = F_x(r_L)$ where : **P(U)** is the proportion of undernourished in total population **(x)** refers to the dietary energy consumption **rL** is a cut-off point reflecting the minimum energy requirement **f(x)** is the density function of dietary energy consumption **Fx** is the cumulative distribution function Data sources are principally country statistics on local food production, trade, stocks and non-food uses; food consumption data from national household surveys; country anthropometric data by sex and age and country population estimates. This evaluation could be more useful by considering geographical areas that may be particularly vulnerable (such as areas with a high probability of major variations in production or supply or areas subject to natural disasters) and specific ethnic or social groups, as well as gender differences. Nevertheless, this kind of assessment is a sensitive issue for a country.	
Key literature FAO (2008); Von Grebmer et al. (2010); UNSCN (2009)	

Susceptibility	
Indicator: **D** **Age Dependency Ratio**	
Measuring unit *Number of dependents (younger than 15 and older than 65) as percentage of working-age (15-64) population*	**Spatial and temporal scale** *Country-based data for 194 countries*
Data sources Human Development Report 2013, Statistical Tables: http://hdrstats.undp.org/en/tables/ World Bank data: http://data.worldbank.org/indicator/SP.POP.DPND	
Periodicity of Data: annual, *updated three times a year (April, September and December)*	

Relevancy of indicator

A high dependency ratio can indicate, in different ways, a population's susceptibility to harm: As the ratio of the economically dependent population to the income generating population, a high value increases the susceptibility to harm as more people are affected if a working person experiences harm (see Schneiderbauer 2007). On the national scale, a high dependency ratio, - can also mean an increase in government expenditures on social services and support schemes (pension funds, etc.).

As proportion of children and elderly to working age population, it can also give a more direct measure of susceptible population as children and elderly are often limited in mobility and thus lack the capacity to individually "move out of harm's way" in case of a hazard (Cutter et al. 2003). The dependency ratio of a given population can thus indicate societal vulnerability, as dependents are more susceptible to harm from disasters.

The total dependency ratio for each country is calculated as follows:

(Total) Dependency ratio = $\frac{0-14+65\,\&\,over}{15-64}\times 100$

Validity/limitations of indicator

The indicator gives an insight into the amount of people of non-working age, compared to the number of those of working age. A high rate of dependent population means, that those segments of the population in working age, and the overall economy, face a greater burden in supporting both groups, namely children (under the age of 15) and senior citizens (age 65 and older), economically and socially in stress situations and when direct and indirect losses due to hazards of natural origin occur.

The working age is commonly 15-64 years (see World Bank), which gives the most reliable data that can be compared at the global scale. Real working age can differ from this model however, either due to a large share of youths staying longer in the educational system or also due to a large share of people working beyond the age of 65.

Key literature:

Cutter et al. (2003); Schneiderbauer (2007)

Susceptibility	
Indicator: **E** Extreme Poverty (*Poverty headcount ratio at $1.25 a day (PPP))*	
Measuring unit *Percentage of population living on less than 1.25 USD/day at 2005 international prices*	**Spatial and temporal scale** *Country-based data for 127 countries*
Data sources World Bank data, World Development Indicators: http://data.worldbank.org/indicator/SI.POV.DDAY	
Periodicity of Data: *annual report (HDR usually launched in October/November), but data not available on annual basis for many countries*	
Relevance of indicator for World Risk Report Poverty is the deprivation of essential goods, services and opportunities (ADB 2004). Poor people are more susceptible to suffer from the impact of natural hazards, as they tend to live in hazard-prone areas (e.g. in unsafe buildings, on floodplains, etc.) and continuously have to cope with various shocks related to hazards, in dire conditions with limited assets (UNDP 2007). Extreme poverty thus increases the susceptibility to harm. Therefore, it is important to use this indicator to identify those people unable to meet their minimal requirements for survival. National poverty line of individual countries shows the level of income or consumption needed to be excluded from the poor cohort of people. However, this cannot be used as a standard measure to compare poverty ratios across countries, as the perceived boundary between poor and non-poor increases with the average income of a country (World Bank 2008). Therefore, this approach will use the international poverty line developed by the World Bank, with regard to the definition: *"international poverty line in local currency is the international* lines of $*1.25 and $2 a day in 2005 prices, converted to local currency using the PPP (purchasing power parities) conversion factors estimated by the international comparison program"* (World Bank 2008:22).	
Validity/limitations of indicator The Indicator shows the proportion of people with an income of less than 1.25 USD PPP per day, which is an indication of extreme poverty. Using an income-based indicator to identify people living under extreme poverty could be a problem, as it does not consider other assets (human, social, natural and physical) that people possess.	
Remarks: Values for OECD countries were assumed as being below 2% of population living on less than 1.25 USD/day. Thus, all OECD countries as well as those whose World Bank Indicator values are below 2% have the same value (1.99).	
Key Literature: ADB (2004); Ravallion et al. (2008); UNDP (2007); UN/ISDR (2009); World Bank (2008)	

Susceptibility	
Indicator: Gross Domestic Product *Gross Domestic Product (GDP) at purchasing power parity (PPP) per capita (current international $)*	
Measuring unit *USD (procedure -Log(USD/max(USD)))*	**Spatial and temporal scale** *Country-based data for 214 countries*
Data sources World Development Indicators: http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators World Bank data: http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD	
Periodicity of Data: annually	
Relevancy of indicator GDP per capita is gross domestic product divided by mid-year population converted to international dollars, using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources (The World Bank). GDP per capita in PPP has been identified as an important determinant of susceptibility and vulnerability by different authors and used in the Disaster Risk Index 2004 (Peduzzi et al. 2009, Schneiderbauer 2007, UNDP 2004) and is commonly used as an indicator for a country's economic development (e.g. Human Development Index (HDI)).	
Validity/limitations of indicator The GDP per capita PPP can serve as an overall measure of economic development and has often been used as an indicator for economic development and vulnerability. The determinants of vulnerability are manifold, however, and some authors have shown, that GDP per capita is not as significant a vulnerability indicator as, for example, health and literacy (Brooks et al. 2005). This might lead to a lower weighting of this indicator. It is still considered useful to estimate a population's susceptibility to harm, as limited monetary resources are seen as an important factor of vulnerability.	
Key Literature: Peduzzi et al. (2009); Schneiderbauer (2007); UNDP (2004); Brooks et al. (2005)	

Susceptibility	
Indicator: Income inequality *GINI Index*	
Measuring unit *Ordinal scale from 0 (equal distribution) to 1 (maximum inequality)*	**Spatial and temporal scale** *Country-based data for 214 countries*
Data sources World Development Indicators: http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators and World Bank data: http://data.worldbank.org/indicator/SI.POV.GINI United Nations University World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database (WIID): http://www.wider.unu.edu/research/Database/en_GB/wiid/	
Periodicity of Data: unknown, data is not available on annual basis for most countries	
Relevancy of indicator Despite the GDP per capita PPP that indicates a country's overall economic achievement, the GINI index is used here in order to additionally depict the wealth distribution within a country. The index gives an estimate of inequality as it measures the extent to which the actual income distribution differs from an equal distribution. The index is obtained from a hypothetical (45-degree) line of absolute equality and the Lorenz curve. This curve is a *cumulative distribution function* of the empirical probability distribution of wealth, by means the cumulative percentages of total income received against the cumulative number of receivers. The ratio of the area between the line of equality and the Lorenz curve over the total area under the line is the GINI coefficient. A result of zero represents perfect equality while an index of 100 implies perfect inequality.	
Validity/limitations of indicator Index relies on data reported by countries. Limitations in comparability might occur due to different average household sizes among countries and from the scale at which GINI is determined (quintile, decile, percentile – GINI coefficient with percentile resolution usually results in higher values than GINI coefficient with quintile resolution)	
Key Literature: Gini (1921); Anand & Segal (2008)	

Table 1: Final Structural Components and Indicators of the World Risk Index

1. Exposure	2. Susceptibility	3. Coping Capacity	4. Adaptive Capacity
Exposed Population with Regard to A) Earthquakes B) Cyclones C) Floods D) Droughts E) Sea level rise	**Public Infrastructure** A) Population without access to improved sanitation B) Population without access to clean water **Housing conditions** Proportion of population in slums; proportion of semi-solid and fragile houses → limited data availability **Nutrition** C) Percentage of undernourished population **Poverty and Dependencies** D) Dependency ratio (proportion of under 15 – and above 65-year-olds in relation to the working population) E) Extreme poverty (population living on less than 1.25 USD (live PPPs) per day) **Economic Capacity and Income** F) Gross Domestic Product per capita (Purchasing Power Parity) G) Gini-Index	**Government and Authorities** A) Corruption Perception Index B) Failed States Index **Disaster Preparedness and Early Warning** National disaster risk management policy according **Medical Services** C) Number of physicians per 10,000 population D) The number of hospital beds per 10,000 population **Social Networks: Neighborhood, Family And Self-Help** **Economic Coverage** E) Insurance (except life insurance)	**Education and Research** A) Adult literacy rate B) Combined gross school enrolment (rate of school-aged children in primary, secondary and tertiary educational institutions) **Gender Equity** C) Gender parity in education (in primary, secondary and tertiary educational institutions) D) Percentage of female representatives in the National Parliament **Environmental Status / Ecosystem Protection** E) Water resources F) Protection of biodiversity and habitats G) Forest Management H) Agricultural Management **Adaptation Strategies** Volume of National Adaptation Programmes of Action to Climate Change, Climate Change Convention (available for 45 of the least developed countries) **Financing** I) Life expectancy at birth J) Private health expenditure K) Public health expenditure

Calculation of Coping Capacity

The calculation of coping capacity is based on several indicators that determine the capacity of a given population and/or nation to immediately react to, or manage the impact of a hazard event. Many variables listed in the process of concept development (by our own expert judgement, as well as by reviewers and respondents of the questionnaire) were examined and tested regarding their data availability and plausibility. Limitations in data availability resulted in the exclusion of various indicators judged highly relevant by many experts and practitioners including, for example, the availability of early warning systems.

The indicators that, at the end, have been used and calculated with existing data are: A) Corruption, B) Governance, C) Number of physicians per 10,000 inhabitants, D) Number of hospital beds per 10,000 inhabitants and E) Insurance coverage.

The coping component is aggregated in two steps: Firstly, the corruption and governance indicators are combined into the group "Government and authorities" whereas the number of physicians and hospital beds will be combined to the group "capacity of the national health system". In the second step, the two groups are aggregated to build the coping capacity component. The aggregation is currently made using equal weights; the two-step aggregation procedure allows for the modification of weights of both individual indicators, as well as groups at a later stage (see figure 3).

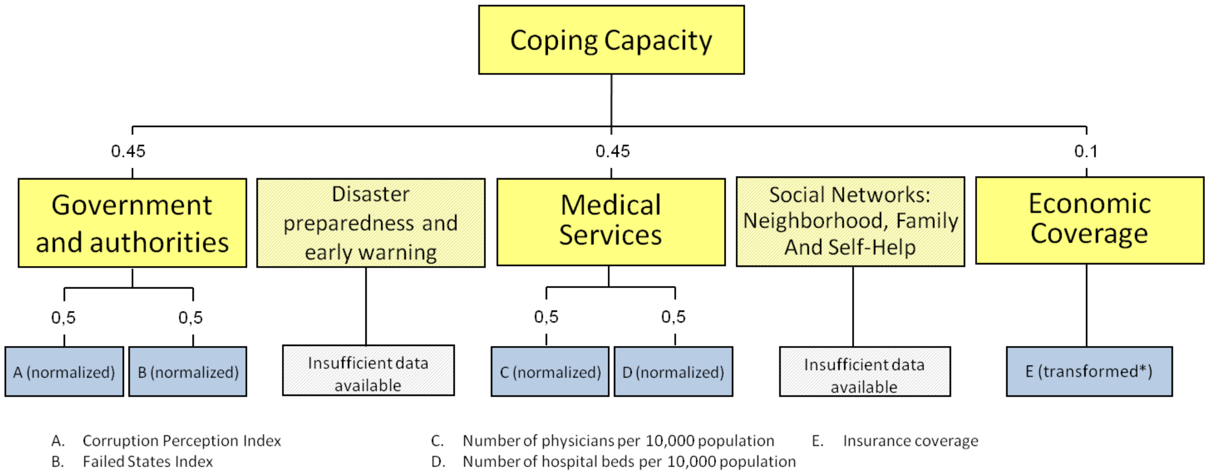

Fig. 3 Aggregation of Coping Capacity Components, source: own figure

The indicators are described in detail in the following.

Coping Capacity	
Indicator: **A** *Corruption Perception Index (CPI)*	
Measuring unit *Ordinary scale from 0 (highest perceived corruption) to 100 (least perceived corruption), normalised to 0 to 1.*	**Spatial and temporal scale** *Country-based data for 176 countries*
Periodicity of data: annual	
Data source: Transparency International: http://cpi.transparency.org/cpi2013/results/ Transparency International updated the methodology used to construct the CPI 2012. The modification includes a simpler approach, which is easy to follow and understand. Furthermore, this new approach better captures changes in perception of corruption over time. The link http://www.transparency.org/files/content/pressrelease/2012_CPIUpdatedMethodology_EMBARGO_EN.pdf provides further information on the updated methodology. Basically, Transparency International now cumulates the raw scores of each indicator to calculate the final country score. In contrast to the previous methodology, the final country score of the 2012 CPI does not relate to any raw scores of other country.	
Relevance of indicator This indicator measures the perceived level of corruption of national governments using 13 different sources. In addition to the results, a confidence range is given: it is larger if there are less source indicators available for calculation. People living in countries with higher level of corruption are thought to have more difficulties recovering from natural hazard impacts, due to limited governmental support reaching affected population compared to states with lower level of corruption. Corruption can further be of particular importance when it comes to the distribution of and access to emergency relief resources. The following sources have been used to construct CPI 2008: Asian Development Bank, African Development Bank, Bertelsmann Transformation Index, Country Policy and Institutional Assessment, Economist Intelligence Unit, Freedom House, Global Insight and Merchant International Group. Additional sources are resident business leaders evaluating their own country; in the CPI 2008, this consists of the following sources: IMD, Political and Economic Risk Consultancy, and the World Economic Forum.	
Validity/limitations of indicator The CPI assesses the level of corruption using qualitative surveys, as there is no general quantitative data available. The CPI uses different sources for different countries due to data limitations. As a result, the confidence intervals for the cases (countries), with few data sources, are very large. For countries with intervals overlapping more than 29%, this means the corruption level is indistinguishable (van Belle G (2008)). The overall reliability of data is demonstrated, however, in the high correlation between sources, as well as in the use of different independent sources and expert interviews.	
Key literature: Lambsdorff (2008); Transparency International (2010)	

Coping Capacity	
Indicator: **B** *Failed States Index*	
Measuring unit: *Ordinal scale with range of 0 (most stable) to 120 (critical), scaled to 0 to 1, with 1 (stable) and 0 (critical)*	**Spatial and temporal scale** *Country-based data for 178 countries*
Data sources The Fund for peace: http://ffp.statesindex.org/rankings-2013-sortable	
Relevance of indicator for World Risk Report The Failed States Index is a vital indicator, as it captures state vulnerability based on 12 variables that can be divided into social, economic and political indicators. Vulnerable states may have difficulties recovering from natural hazard impacts, owing to their critical inherent characteristics. The indicators used in the Failed States Index according to the Fund for Peace include: 1. Mounting Demographic Pressures (in relation to food supply, participation etc.) 2. Massive Movement of Refugees or Internally Displaced Persons creating Complex Humanitarian Emergencies 3. Legacy of Vengeance-Seeking Group Grievance or Group Paranoia (related to e.g. institutionalized political exclusion or public scapegoating of groups) 4. Chronic and Sustained Human Flight ("brain drain", growth of exile communities) 5. Uneven Economic Development along Group Lines (group-based inequality, impoverishment, rise of communal nationalism) 6. Sharp and/or Severe Economic Decline (sudden drop in commodity prices, devaluation of national currency, growth of hidden economies etc.) 7. Criminalization and/or Delegitimization of the State (e.g. massive corruption by ruling elites, loss of popular confidence in state institutions) 8. Progressive Deterioration of Public Services (disappearance of basic state functions, but services for ruling elites remain intact) 9. Suspension or Arbitrary Application of the Rule of Law and Widespread Violation of Human Rights (e.g. emergence of authoritarian rule, outbreak of political violence, rising number of political prisoners) 10. Security Apparatus Operates as a "State Within a State" (e.g. state-sponsored or –supported private militias, private armies) 11. Rise of Factionalized Elites (fragmentation of ruling elites and state institutions along group lines, nationalistic political rhetoric) 12. Intervention of Other States or External Political Actors (external intervention that affects internal balance of power) The surveys were conducted using groups of experts that were interviewed separately. In case of significant differences in their answers, a third, randomly selected expert is interviewed.	
Validity/limitations of indicator The Conflict Assessment System Tool (CAST) methods are used. The validation is made by the comparison of the CAST results to local expert opinions.	
Remarks: No correspondence between Failed States and Corruption Perceptions Index for a single country, but there is a correlation in trends (ordinal correlation → most failed states are also corrupt).	

Coping Capacity	
Indicator: **C** *Number of physicians per 10,000 people*	
Measuring unit *Physicians per inhabitant scaled from 0 to 1, presuming a maximum of 1:100 physicians per inhabitant*	**Spatial and temporal scale** *Country-based data for 214 countries*
Data sources World Health Organization, Global Health Observatory Data Base, World Health Statistics, Health Workface: http://apps.who.int/ghodata/# and World Development Indicators: http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators World Bank data: http://data.worldbank.org/indicator/SH.MED.PHYS.ZS	
Periodicity of Data: data is not available on annual basis for most countries	
Relevancy of indicator for world risk report The number of practicing physicians qualified from medical schools, in proportion to 10,000 inhabitants, allows the international comparison of available health care, which is a crucial coping measure in the aftermath of a disaster. The general assumption is that those regions, which have a significantly lower ratio of practicing physicians to 10,000 people, are also those that might face higher difficulties in coping with extreme events and emergencies. Overall, the indicator can be used to estimate the capacity of a health care system of a country.	
Validity/limitations of indicator The doctor-patient ratio can serve as a general measure of a health care system. In order to allow the comparison of this indicator with the number of hospital beds (scaled to 10000 inhabitants), the ratio is inversed to physicians per inhabitant and then normalised on a scale from 0 to 1.	
Remarks:	
Key literature: IDEA (2005)	

Coping Capacity	
Indicator: **D** *Number of hospital beds per 10,000 persons*	
Measuring unit *hospital beds per inhabitant scaled from 0 to 1, presuming a maximum of 1:50 hospital beds per inhabitant*	**Spatial and temporal scale** *Country-based data for 193 countries*
Data sources World Health Organization, Global Health Observatory Data Base, World Health Statistics, Health Infrastructure: http://apps.who.int/ghodata/# and World Bank, World Development Indicators: http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators World Bank data: http://data.worldbank.org/indicator/SH.MED.BEDS.ZS	
Periodicity of Data: unknown, data is not available on annual basis for most countries	
Relevancy of indicator Hospital beds indicate also the capacity of the medical care infrastructure to help or support societies in the case of a mass emergency and disaster with respective treatment. Hospital beds in private, general and specialised hospitals, medical and rehabilitation centres are included. Although hospital beds do not provide any information about the standard of these hospitals and their treatment, the general comparison of the capacities of hospital beds per 10,000 people provides a first overview of those regions where this infrastructure is significantly lower than in others.	
Validity/limitations of indicator Overall, some experts argue that the indicator "hospital beds" is rather weak, since it solely provides information on the health care capacity. Therefore, this indicator should be supported by an appropriate mix of staff and equipment indicators as well (McKee 2004). Since this information is not available in global datasets, the respective extension of the assessment of hospital capacities could not be made in this proposal.	
Remarks: Need to disaggregate data by urban/rural to show significant variations	
Key literature: McKee (2004)	

Coping Capacity	
Indicator: **E** *Insurance coverage (except life insurance)*	
Measuring unit *Ordinal scale with range from 0 to 6, transformed as follows:* 0->0 1->0.25 2->0.5 3->0.5+0.5*(1/4)=1/2+1/8=0.625 4->0.5+2*0.5*(1/4)=1/2+2/8=0.75 5->0.5+3*0.5+(1/4)=0.875 6-> 1	**Spatial and temporal scale** *Country-based data*
Data sources Munich Re, not publicly available	
Periodicity of Data: annual	
Relevancy of indicator Classification of the world by property insurance premium (non-life including health) per capita The insurances and reinsurances have been considered as important tools for disaster risk transfer, particularly at the Hyogo Framework for Action 2005-2015, which include them as part of the social and economic development practices for the reduction of the underlying risk factors: "*Promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters*" (UNISDR, 2005). The accounting of the level of insurance for countries has been part of previous disaster risk assessment programs, such as the America's Indicators Program (IDB-IDEA) for the Prevalent Vulnerability Index (PVI). Here the indicator relevance was declared as "*an adequate coverage of potential losses in housing and public and private goods by the insurance industry signifies greater financial protection for the population when faced with feasible hazards*" (Cardona et al. 2005).	
Validity/limitations of indicator The data available enables only the classification of countries by ranges defined by the Munich Re for the insurance coverage. This assessment doesn't allow the establishment of more detailed differences among countries.	
Remarks:	
Key literature: IDEA (2005), UNISDR (2005)	

Calculation of Adaptive Capacity

Indicators for the adaptive capacity of a state need to portray the long-term response capacities to natural hazards and/or environmental change. They should grasp the ability of a society or community to transform or adapt, in order to alter (reduce) the vulnerability to this change.

The indicators specified below were selected based on expert judgement as well as on data availability. The component on adaptive capacity contains four groups – education, health status of the population per country, gender equity and environment - which are set up as follows:

Education:

A) Adult literacy rate

B) Combined gross school enrolment ratio

Gender Equity:

C) Gender parity in primary, secondary and tertiary education

D) Proportion of seats held by women in national parliament

Environment, Ecosystem Vitality:

E) Water (effects on ecosystem) (Change in water quantity)

F) Biodiversity & Habitat (Biome Protection, Marine Protection, Critical Habitat Protection)

G) Forests (Forest Lost, Forest Cover Change, Growing Stock Change)

H) Agriculture (Agricultural Subsidies, Pesticide Regulation)

Financing:

I) Public expenditure on health

J) Life expectancy at birth

K) Private expenditure on health

Following a similar methodology of aggregation as regarding the other factors (susceptibility and coping), the sub-variables (A to K) of the adaptation/adaptive capacity factor are combined to the respective group first and the groups are combined to "adaptive capacity". In a second step, a weighting for all four aggregated indicators (Education, Financing, Gender Equity and Environment) has

been applied. The variables are currently combined using equal weights (see figure 4).
In the "Financing" group, this leads to a higher weight of health expenditures compared to life expectancy as two-thirds of the variables "Financing" refer to expenditure whereas one-third refers to life expectancy. It can be argued, that expenditure on health represents a criterion that is easier to change than a population's life expectancy. This means that an alteration of expenditure on health can reveal efforts to enhance the adaptive capacity sooner than the indicator of life expectancy, which is able to capture the long-term changes.
The consideration of gender in the disaster risk context is important because it represents equity in a society, and it takes into account not only the role of women in familial and local culture development but also their capabilities to manage in the intellectual and practical scenarios. In this way, countries with high levels of women participation in education, politics and economic fields show their empowerment in the active actual life, which can be regarded as strength to overcome future crisis.
The indicators on environmental aspects are taken from the Environmental Performance Index (EPI) which is produced by environmental experts from Yale University and Columbia University. The EPI is made up of ten policy categories containing a total of 25 indicators based on the best data available from international organizations and research institutes (http://epi.yale.edu/ for further information). Instead of integrating the whole EPI, four of its policy categories were selected to build the environment group in order to avoid duplication and to fit the concept of adaptive capacity. These indicators mainly outline environmental conditions and degradation processes that in the medium and long-run have also an influence of the adaptive capacity of societies and socio-ecological systems in particular.

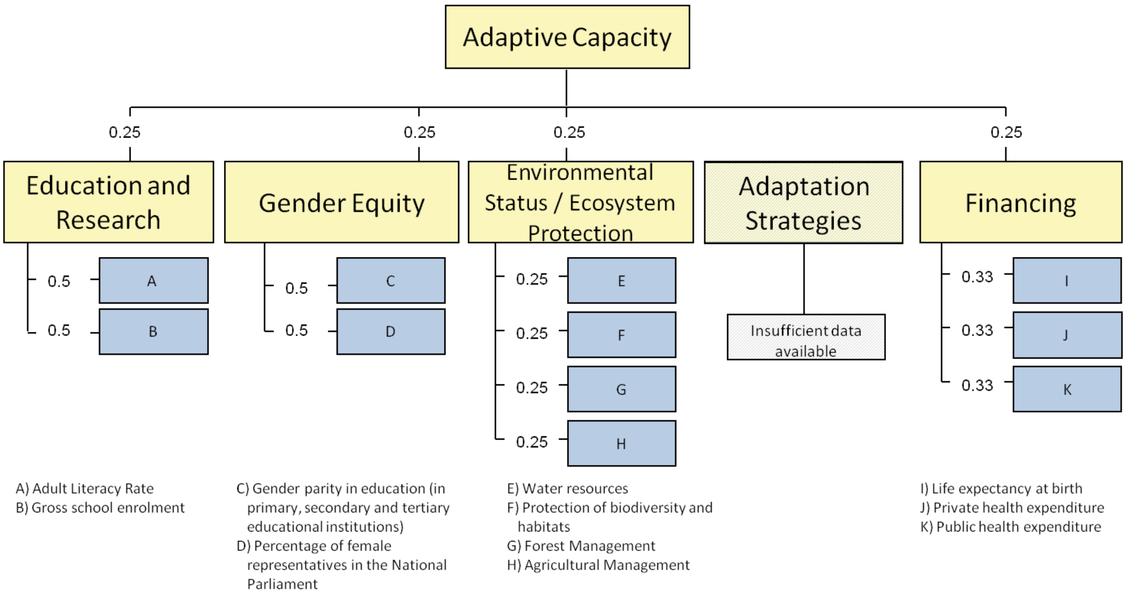

Fig.4 Aggregation of Adaptive Capacity Components, source: own figure

Adaptive Capacity	
Indicator: **A** *Adult Literacy rate per country*	
Measuring unit *Population aged 15 years and above* who can read and write a short simple statement on their everyday life	**Spatial and temporal scale** *Country-based data for 209 countries*
Data sources UNESCO, Institute for Statistics: http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=136&IF_Language=eng&BR_Topic=0 World Bank data: http://data.worldbank.org/indicator/SE.ADT.LITR.ZS	
Periodicity of Data: Annually, but based on surveys over a longer period of time	
Relevancy of indicator This is defined as the percentage of population aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday lives (ADB 2004:19). Adult literacy rate shows the accumulated achievement of primary education and basic literacy skills of the population crucial for economic, social and political participation and development, especially in today's knowledge societies (UNESCO 2006). Moreover, literacy could be an essential indicator, when empowering people on hazard risk reduction. Illiteracy rate indicates low quality of primary education and needs for policies in organising adult literacy programs. Those without literacy skills may have problems taking advantage of health, educational, political, economic and cultural opportunities (UNESCO 2006). Moreover, illiterate people may have difficulty in understanding warnings and access to recovery information (Cutter et al. 2003).	
Validity/limitations of indicator This indicator shows the adult literacy rate per country. Some countries apply definitions and criteria different to international standards defined above, which could be a limitation (UNESCO Institute for Statistics 2008).	
Remarks: Adult literacy rate can be presented by gender, in order to show gender variations.	
Key literature: ADB (2004); Cutter et al. (2003); UNESCO (2006); UNESCO Institute for Statistics (2008)	

Adaptive Capacity	
Indicator: B *Combined Gross Enrolment Ratio (GER)*	
Measuring unit *Proportion of pupils enrolled in a given level of education*	**Spatial and temporal scale** *Country-based data for 209 countries*
Data sources UNESCO, Institute for Statistics: http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=136&IF_Language=eng&BR_Topic=0	
Periodicity of Data: data is not available on annual basis in some countries	
Relevancy of indicator A good level of educational attainment is important not only to find a secure job, or climb up the ladder of social mobility to achieve higher socio-economic status, but also to recover sooner from shocks related to natural hazards. A good level of education also improves the capacity of a society and different groups to potentially change from one economic activity (e.g. farming) to another (e.g. small-scale business). In this context, the gross enrolment ratio is a vital indicator that captures adaptive capacity, as it measures education access and coverage. It shows the general level of participation in a given level of education and further indicates the capacity of the education system to enrol students of a particular age group (UNESCO glossary). It also provides some indication of internal efficiency of the educational system. It defines total enrolment in a specific level of education, regardless of age, expressed as a percentage of the eligible official school-age population corresponding to the same level of education in a given school year (UNESCO glossary). Gross enrolment ratio per country can be presented by gender and level of education (primary and secondary).	
Validity/limitations of indicator A high GER generally indicates a high degree of participation, whether the pupils belong to the official age group or not. A GER value approaching or exceeding 100% indicates that a country is, in principle, able to accommodate all of its school-age population, but it does not indicate the proportion already enrolled (UNESCO glossary). GER can exceed 100%, due to the inclusion of over-aged and under-aged pupils/students because of early or late entrants, and grade repetition (UNESCO glossary).	
Remarks: Gross enrolment ratio per each country can be presented by gender and level of education (primary and secondary), in order to give a clear picture.	
Key Literature: UNESCO Institute for Statistics (2008)	

Adaptive Capacity

Indicator: C

Gender Parity in primary, secondary and tertiary education

Measuring unit	**Spatial and temporal scale**
Ratio of girls to boys, based on UNESCO data on school enrolment *Values: 1 = parity* *> 0 < 1 = disparity in favour of males* *>1 = disparity in favour of females*	*Country- based data for around 209 countries*

Data sources

UNESCO, Institute for Statistics: http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=136&IF_Language=eng&BR_Topic=0

Periodicity of Data: annual

Relevancy of indicator

Gender parity in education is an indicator for female participation and can hence be seen as a general measure for gender equality. The equality of educational opportunities is a basic state to increase the status and capabilities of women.

In the disaster risk context, education forms an important resource for adaptation as it prepares a community to understand natural hazards, disaster consequences and the value of organization and cooperation in crisis time, where women have a special role because of their strong sense of protection of family and environment.

Validity/limitations of indicator

The indicator gives a measure on the current gender balance in education. The change in the ratio over time does not explain female access to education sufficiently, however, as an increased ratio can result from both, an increase in female participation as well as a decrease in male participation. It also does not show whether those enrolled in school complete the relevant education cycles.

Another limitation of the indicator is the relation it has with the school age population. In the case school age population deviates significantly from 1, the gender parity in enrolment would not be adequately reflected.

Key literature:

UNDP (2009)

Adaptive Capacity	
Indicator: D *Proportion of seats held by women in national parliament*	
Measuring unit *Proportion of seats held by women in national parliaments is the number of seats held by women expressed as a percentage of all occupied seats.*	**Spatial and temporal scale** *Data are available for 196 countries*
Data sources Millennium Development Goals Indicators: http://mdgs.un.org/unsd/mdg/Data.aspx World Bank data: http://data.worldbank.org/indicator/SG.GEN.PARL.ZS	
Periodicity of Data: Annually. Commonly available from national parliaments and updated after an election.	
Relevancy of indicator Women's representation in parliaments is one aspect of women's opportunities in political and public life, and it is therefore linked to women's empowerment. This indicator gives an idea of the progress of women participation in the highest levels of society, such as the decision making process, and becoming a leader and voice of the community.	
Validity/limitations of indicator Seats refer to the number of parliamentary mandates, or the number of members of parliament. There can be difficulties in obtaining information on by-election results and replacements due to death or resignation. These changes are ad hoc events which are more difficult to keep track of. By-elections, for instance, are often not announced internationally as general elections are. The data excludes the numbers and percentages of women in upper chambers of parliament. Seats are usually won by members in general parliamentary elections. Seats may also be filled by nomination, appointment, indirect election, rotation of members and by-election. In terms of measuring women's contribution to political decision making, this indicator may not be sufficient because some women may face obstacles in fully and efficiently carrying out their parliamentary mandate.	
Key literature: UNDP (2009)	

Adaptive Capacity	
Indicator: E *Water resources (wastewater treatment)*	
Measuring unit *Ordinal scale with a range from 0 (very poor environmental performance) to 100 (excellent environmental performance)*	**Spatial and temporal scale** *Country-based data*
Data sources Yale Center for Environmental Law & Policy; Environmental Performance Index 2014 http://epi.yale.edu/	
Periodicity of Data: according to the EPI evaluation, biannual. Each component of the index uses time series to show the change over time. For water quality: period 1990-2009, for water stress: 1950-1995, for water scarcity: 1975-2007.	
Relevancy of indicator This indicator tracks how well countries treat wastewater from households and industrial sources before it is dumped into the environment. It tracks the performance of basic wastewater management. Untreated sewage can disrupt the functioning of downstream ecosystems. Wastewater is comprised of domestic grey-water (water from baths, sinks, washing machines, and kitchen appliances) and black-water (water from toilets), as well industrial wastewater that may have additional chemical contaminants. It typically contains nutrients and chemicals that pollute natural water systems, resulting in a range of impacts from algal blooms to biological endocrine disruption. In rural areas, where pit latrines or septic systems are prominent, pollutants tend to be dispersed in the environment. In urban areas, however, functioning sewage systems that collect and treat wastewater concentrate the pollutants into discrete discharges that are more easily treatable. The practice of water treatment is vital for the health of aquatic systems, provides health benefits for local residents, and ensures that clean water is available for re-use. Good wastewater management is especially relevant for areas facing more significant impacts of climate change and rapid population growth, since such areas may face more constrained water resources in the future. (Hsu et al. 2014).	
Validity/limitations of indicator This indicator assesses the proportion of wastewater that is treated for those households that are connected to the sewerage system. It measures wastewater that mostly comes from household sources, but in some cases industrial sources contribute if they share the municipal collection network. This varies on a country-by-country basis. Despite the known limitations, expert review confirms that this measure still provides a useful metric against which to judge country performance.	
Key literature: Hsu et al. (2014)	

Adaptive Capacity

Indicator: F
Ecosystem vitality: Biodiversity & Habitat
Conformed by three components: Terrestrial Protected Areas (National Biome Weights), Terrestrial Protected Areas (Global Biome Weights), Marine Protected Areas and Critical Habitat Protection

Measuring unit	**Spatial and temporal scale**
Ordinal scale with a range from 0 (very poor environmental performance) to 100 (excellent environmental performance), aggregated from 3 performance indicators	*Country-based data*

Data sources

Yale Center for Environmental Law & Policy; Environmental Performance Index 2014
http://epi.yale.edu/

Periodicity of Data: according to the EPI evaluation, biannual

Relevancy of indicator

Humans rely on natural resources to serve the most basic of our needs—including food, water, clothing, and shelter. Yet our collective impact on the planet's ecosystems threatens the very resources that have allowed us to thrive as a species. The targets seek to protect the Earth's biological diversity and promote the sustainable use of natural resources and the equitable sharing of the benefits we derive from ecosystem services. The EPI charts each country's progress in achieving these goals (Hsu et al. 2014)

Habitat protection is a necessary but not sufficient condition for the conservation of biodiversity and ecosystem services that are critical to sustain human life and well-being. The Critical Habitat Protection indicator examines the extent of protection of the last remaining habitats for endangered or critically endangered species (according to the IUCN criteria). The EPI's measurement of terrestrial and marine protected areas stems from the targets set by the Convention on Biological Diversity (CBD), which established protection goals of 17 percent of terrestrial and inland water areas and 10 percent of marine and coastal areas.

Validity/limitations of indicator

"The effective protected area conservation value per country-biome is based on three 1 km global spatial datasets: World Database on Protected Areas (2007), (b) the CIESIN and Wildlife Conservation Society Human Footprint (2007); and biomes from the WWF Ecoregions of the World dataset" (Olson et al., 2001:45).

Weights between the four indicators are distributed equally according the information and data founded (e.g. landlocked countries – no protected areas, no alliance for zero extinction sites), which means that when one of them is missing the weight of the others would be equally distributed (Emerson et al., 2010).

Key literature:

Hsu et al. (2014); Olson et al. (2001); Emerson et al. (2010a)

Adaptive Capacity	
Indicator: G *Ecosystem vitality: Forests* *The Change in Forest Cover indicator measures the percent change in forest cover between 2000 and 2012 in areas with greater than 50 percent tree cover.*	
Measuring unit *Ordinal scale with a range from 0 (very poor environmental performance) to 100 (excellent environmental performance), aggregated from 3 performance indicators*	**Spatial and temporal scale** *Country-based data*
Data sources Yale Center for Environmental Law & Policy; Environmental Performance Index 2014 http://epi.yale.edu/	
Periodicity of Data: according to the EPI evaluation, biannual	
Relevancy of indicator It factors in areas of deforestation (forest loss), reforestation (forest restoration or replanting) and afforestation (conversion of bare or cultivated land into forest). Reduction in the extent of forest cover has significant negative implications for ecosystem services and habitat protection. Forests are dynamic ecosystems vital to sustaining natural life cycles, biodiversity, and the prosperity of humankind. Forests play a critical role in mitigating the effects of climate change and providing integral ecosystem services and products. Policymakers increasingly acknowledge the significance of forest ecosystems as scientists place greater emphasis on the role of forests as carbon sinks to combat global climate change and in regulating the hydrological system.	
Validity/limitations of indicator The Hansen et. al (2013) satellite-based mapping system of global forest change would benefit from differentiating between forest use practices to properly measuring global forest change. It is possible, however, that no satellite will ever be able to fully capture such practical, grounded realities. As for the previous environmental indicators the weights are equally distributed and in case one of the two is missing the other one will weight 100%.	
Key literature: Hsu et al. (2014); Hansen et al. (2013)	

Adaptive Capacity

Indicator:H

Ecosystem vitality: Agriculture

This indicator is composed by: Agricultural Subsidies (AGSUB) and Pesticide Regulation (POPs)

Measuring unit	**Spatial and temporal scale**
Ordinal scale with a range from 0 (very poor environmental performance) to 100 (excellent environmental performance), aggregated from 2 performance indicators	*Country-based data*

Data sources

Yale Center for Environmental Law & Policy; Environmental Performance Index 2014 http://epi.yale.edu/

Periodicity of Data: according to the EPI evaluation, biannual

Relevancy of indicator

Agriculture is one the economical activities that causes more impacts to ecosystems. The pressure over water and land, and the use of pesticides are some of them. The agriculture indicator gives an idea of this situation.

Agricultural Subsidies is a proxy measure for the degree of environmental pressure exerted by subsidizing agricultural inputs. Pesticide Regulation assesses the status of countries' legislation regarding the use of chemicals listed under the Stockholm Convention on Persistent Organic Pollutants (POPs). Pesticide Regulation also scores the degree to which these countries have followed through on limiting or outlawing these chemicals.

According to the OECD, public subsidies for agricultural protection and agrochemical inputs exacerbate environmental pressures through the intensification of chemical use, the expansion of farmland into sensitive areas, and the overexploitation of resources like water and soil nutrients. Pesticides are a significant source of pollution in the environment. They kill beneficial insects, pollinators, and fauna, and human exposure to pesticides has been linked to increased rates of neurological and reproductive disorders, endocrine disruption, and cancer.

Validity/limitations of indicator

Unfortunately, neither indicator in this category is a direct measurement of agricultural environmental performance. Instead, they are both proxies related to policy intent. Globally comparable measures to assess agricultural sustainability or impacts simply do not exist. Measures of soil quality and erosion, agricultural water-use intensity, and desertification are all important issues related to agricultural sustainability.

The weights for the three indicators was defined using the Principal Component Analysis, which gives a 50% weight to the pesticide regulation, then 30% to the agricultural subsides and finally 20% to the water intensity (Emerson et al. 2010a).

In the case of agriculture subsidies, for all other missing values, it was assumed a zero. "*Low and middle-income countries without agricultural subsidies data were imputed a proximity to target score of 0 on the basis that most non-OECD countries do not subsidize their agricultural sector"* (Emerson et al. 2010b:52).

Key literature:

Hsu et al. (2014); Emerson et al. (2010b); OECD (2004)

Adaptive Capacity	
Indicator: I *Per capita government expenditure on health*	
Measuring unit *USD PPP, logarithmized and normalised to 0 to 1*	**Spatial and temporal scale** *Country-based data for 191 countries*
Data sources World Health Organization, Global Health Observatory Data Base, World Health Statistics, Health Expenditure: http://apps.who.int/ghodata/#	
Periodicity of Data: annual	
Relevancy of indicator High government expenditure on health is understood to be an indicator for the quality of the health system, which is an important factor of adaptive capacity because medical services represent important sources of post-disaster relief. *"The lack of proximate medical services will lengthen immediate relief and longer-term recovery from disasters"* (Cutter et al. 2003). In our understanding, the lack of medical services is not only expressed by direct capacities as hospital beds and physicians, which are responsible for coping, but also by the lack of access to these services, which are determined by the health system. While the proportion of private expenditure measures the equality of this access within a country, the per capita government expenditure on health gives a measure on the amount of the health expenditures and thus allows the comparison of the quality of the health system among countries. The indicator comprises the following types of expenditure: *"The sum of outlays for health maintenance, restoration or enhancement paid for in cash or supplied in kind […] by government entities, such as the Ministry of Health, other ministries, parastatal organizations or social security agencies (without double counting government transfers to social security and extrabudgetary funds). It includes all expenditure made by these entities, regardless of the source, so includes any donor funding passing through them. It includes transfer payments to households to offset medical care costs and extrabudgetary funds to finance health services and goods"* (WHO 2010: 95).	
Validity/limitations of indicator *The usefulness of the indicator relies largely on the quality and accuracy of input data. According to the indicator compendium of WHO "[t]he most comprehensive and consistent data on health financing is generated from national health accounts. Not all countries have or update national health accounts and in these instances, data is obtained through technical contacts in-country or from publicly-available documents and reports. Missing values are estimated using various accounting techniques depending on the data available for each country"(WHO 2010:213).*	
Key Literature: Cutter et al. (2003); Brooks et al. (2005); WHO (2010); UNDP (2007)	

Adaptive Capacity	
Indicator: **J** *Life expectancy at birth by country*	
Measuring unit *Years of individual life expectancy* *(procedure: 0.25*Log(log(85/Years of individual life expectancy)))*	**Spatial and temporal scale** *Country-based data for 194 countries*
Data sources International Human Development Indicators: http://hdrstats.undp.org/en/indicators/69206.html World Bank data: http://data.worldbank.org/indicator/SP.DYN.LE00.IN	
Periodicity of Data: Annually	
Relevance of indicator Continuous hazards, in general, lower the life expectancy. Nevertheless, life expectancy at birth reflects the overall mortality level of a population. It summarises the mortality pattern that prevails across all age groups – children and adolescents, adults and the elderly (World Health Organization's Statistical Information System - WHOSIS). This indicator also reveals the general health standards of a country, therefore, vital to include it. In terms of definition: average number of years that a newborn is expected to live if current mortality rates continue to apply (WHOSIS).	
Validity/limitations of indicator Life expectancy can indicate general health standards and overall living conditions in a country (WHO 2008).	
Key Literature: WHO (2008); UNDP (2010); WHOSIS (2007)	

Adaptive Capacity	
Indicator: K Private per capita expenditure on health (percentage of total health expenditure)	
Measuring unit USD PPP, logarithmized and normalized to 0 to 1	**Spatial and temporal scale** Country-based data for 191 countries
Data sources World Health Organization,Global Health Observatory Data Base, World Health Statistics, Health Expenditure Ratios: http://apps.who.int/ghodata/	
Periodicity of Data: annual	

Relevancy of indicator for world risk report

The proportion of private expenditure on health can be used as an indicator for the general structure of the health system of a state and determines whether equal access to health services is granted. It is presumed that high proportions of private expenditure on health indicate the lack of a reliable public health system and thus determine the adaptive capacity.

Equal access to health services would be very important when it comes to the recovery from hazard impacts as people might not only suffer from the actual impact, but also be restrained economically if they have to cover medical expenses with private means. The lack of access to adequate health services would thus lead to a large proportion of people with poor health who are not able to adapt to the risk of a novel hazard impact.

The indicator comprises the following types of expenditure: *"The sum of outlays for health by private entities, such as commercial or mutual health insurance, non-profit institutions serving households, resident corporations and quasi-corporations not controlled by government with a health services delivery or financing, and households"* (WHO 2010).

In order to ensure the comparability with the second health expenditure indicator, the value is transformed from the percentage into USD PPP (calculated from private expenditure on health as a percentage of total expenditure on health and per capita total expenditure on health) and then logarithmized and normalized.

Validity/limitations of indicator

The usefulness of the indicator relies largely on the quality and accuracy of input data. According to the indicator compendium of WHO "[t]he most comprehensive and consistent data on health financing is generated from national health accounts. Not all countries have or update national health accounts and in these instances, data is obtained through technical contacts in-country or from publicly-available documents and reports. Missing values are estimated using various accounting techniques depending on the data available for each country"(WHO 2010:213).

Key Literature:

Cutter et al. (2003); Brooks et al. (2005); WHO (2010); UNDP (2007)

Calculation of the WorldRiskIndex

Every major factor – exposure (a), susceptibility (b), coping (c) and adaptation (d) - of the WorldRiskIndex is calculated individually. In order to develop a common index that can be illustrated and displayed cartographically, the following aggregation process was conducted and processed (see Figure 5). The coping capacity and the adaptive capacity were subtracted by one, because positive values represent good coping and adaptive capacities (desirable). However, the Susceptibility Index indicates deficiencies, thus also the positive coping and adaptive capacities had to be transferred into the reverse information on the lack of coping and adaptive capacities. This was done by reversing most of the indicators – if, e.g., 30% of the total population have access to sanitation, then the reverse means that 70% of the population are having no access or a very limited access to sanitation. This is essential in order of being able to combine these indicators with the indicators selected for susceptibility. Thereafter, the combined susceptibility, lack of coping and lack of adaptation index was weighted or multiplied with the Hazard Exposure Index (see Figure 5).

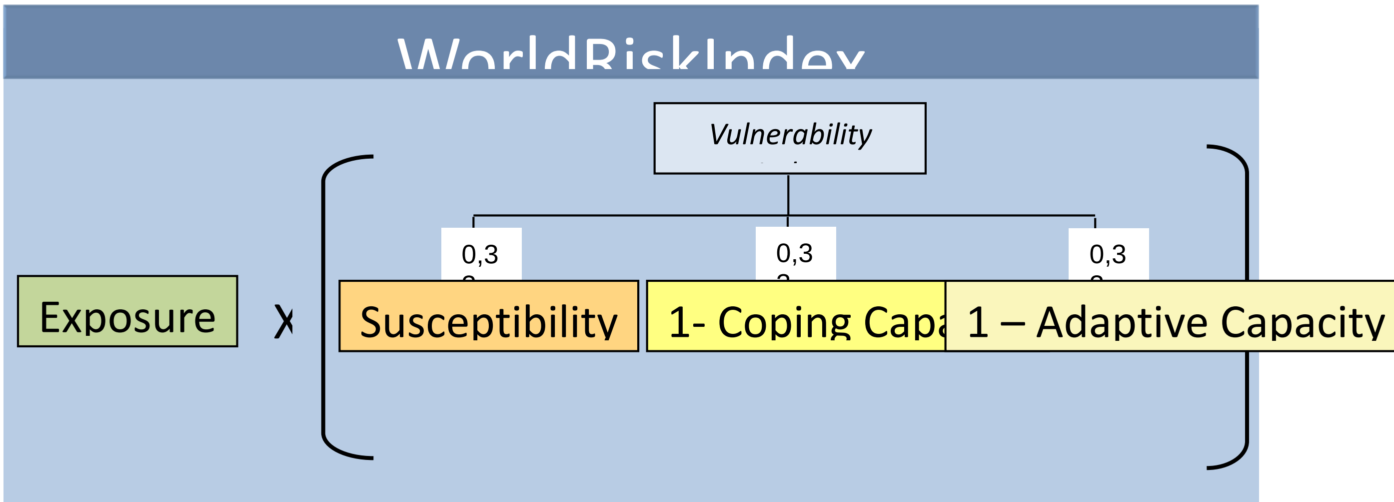

Fig. 5 Aggregation of WorldRiskIndex, source: own figure

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