|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sector |  | Exposure | Sensitivity | Capacity |
| Water | Quant | **Projected change in precipitation (%).** Gross measure of threat to water resource – change in run-off would be better but not available currently in a comprehensive and authorative data set. {Need an adjustment for very arid regions as % is distorting[[1]](#footnote-1)} | **% internal water extracted for all uses.** Indication of how much of the nationally controllable resource is already being used. {Have to consider whether this should be internal + external water} | **% population with access to improved water supply.** High % indicates capacity to deliver water to the population and hence lower vulnerability. |
|  | Qual | **Projected change in temperature** (needs scaling). Water quality issues rise in warmer conditions as disease growth & spread increases; less water for sanitation etc. {Also brings temperature into the axis} | **Existing incidence of water borne diseases**. Measure of current extent of problem. {Check precisely which variable} | **% population with access to improved sanitation**. As above. |
| Food | Quant | **Projected change in agricultural (cereal?) yield** (cf Wheeler) | **% population in rural sector**. These are most sensitive to impacts either through direct food production or loss of livelihood. | **Recent rate of yield increase as ratio of rate of population increase.** If yield increase is not keeping up with population then capacity poor. {What to do for countries with no cereal production?} |
|  | Qual | **Calorie deficit**. If a country is already in deficit then exposed to further shocks. | **% GDP in food imports**. {This could be swapped with exposure variable but the effect on the final index would not be changed.} Score high % as high sensitivity although there could be an argument for the opposite. | **% malnourished children**. Can this be done as “compared with the expected number for the calorie deficit” or “with GDP/cap”? |
| Health | Quant | **Estimated impact of current CC on DALYs**. Will have to use regional estimates for blocks of countries. {I have them} | **Doctor & Nurses per cap**. Attempt to measure on-the-ground delivery of health services. {How does this relate to hospital beds per cap?} | **Longevity**. Better longevity implies better capacity either through medical services or through community practices. |
|  | Qual | **% deaths dues to communicable diseases malnutrition etc** - problem: good reporting but only for 2002 – but it is an exposure snapshot | ??? | **Mortality rate of under 5 year olds**. Can this be estimated compared with a broader national health index to determine failure to deliver to young children?  Replace with maternal mortality |
| Coastal | Quant | **% land below 5 m.** This is the zone that is subject to threats from SLR and storms. | **% Population in the zone below 5m.** Sensitivity of both people and to a large extent infrastructure. | $GDP/Area??? As in GAIN 0.5 |
| {Maybe have only 1 line of variables for the three infrastructure indicators – so omit this row} | Qual | **Storm frequency** – probably estimated from CRED and corrected for length of coastline | **Area of coastal wetland as % of total land**. Coastal wetlands are usually important buffers against storms and important zones for fishing etc | ??? |
| Transport/infrastructure | Quant | **Count of floods and possibly storms (CRED)**. But how to scale this? By land area or by population? | **% of formed and sealed roads of total roads**. | **Ratio of road density to population density**. Low value implies low capacity to deliver. {Needs to be explored} |
|  | Qual |  |  |  |
| Energy | Quant | **% energy derived from either imports or hydro**. As both could be vulnerable under CC. | **Mean energy use per capita.** Sensitivity decreases as a basic level is approached – then what? – plateau or does sensitivity rise again? | **% population with access to reliable energy**. Measure of the capacity to deliver until now. |
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**Var.** **[PPT% ]**

**Issues :**

**Scaling :**

**Cross Correlation :**

**Reporting & Time Series :**

**Actionable :**

**Private Sector Messages** **:**

**Public Sector Messages :**

**Alternate or related measures :**

**Summary :**

Discussion

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sector |  | Exposure | Sensitivity | Capacity |
| Water  See Box 1 for the relationship between the GAIN and the Water Povert Index (WPI) | Quant  **** | **Projected change in precipitation (%).** **[PPT% ]** Gross measure of threat to water. This is the commonly used indicator in both the scientific and response communities. However it is not a very effective measure as it does not take increased evaporative demand into account nor changes in the intensity and seasonality of the rainfall. It might eventually be replaced by a more integrating measure such as run-off or even precipitation minus evapotranspiration. The use of a single measure for an entire country is not very valid, especially for large countries where there are large gradients across the country.  **Issues :** An increase in PPT% is taken to indicate reduced vulnerability. However, this might be misleading for dry countries where a large % increase does not imply a large absolute increase in rainfall or in rainfall effectiveness. The increased rain may come in flooding events. Similarly increased PPT% for already wet countries probably provides little useful additional water and may add to flood loads. There appears to be no objective way to correct for these problems but a subjective correction is suggested below.  It can also be argued that PPT% is is a reasonable approximation – for countries with low current precipitation an increase will be disruptive especially if flood frequency increases; for high precipitation countries additional precipitation is also disruptive. There is a range in the middle where additional rainfall might be beneficial but it is hard to adjust for this. Note however, that this is partially taken up in the AG WHEELER.  **Scaling :** The base value is taken to be no change and the index is scaled so that the most negative countries score -1 and the most positive +0.5. This partially accounts for the issues discussed in the previous paragraph.  **Cross Correlation :** Very low  **Reporting & Time Series :** All countries and a single measure only as it is a projection.  **Actionable :** Only via mitigation of GHG emissions.  **Private Sector Messages** **:** None {This is a mitigation issue. Obviously the private sector can play a role there but that is not the purpose of this index.}  **Public Sector Messages :** Actionable through mitigation.  **Alternate or related measures : See comment on run-off above.**  **Summary :** Acceptable for now, but seek eventually to update with a better measure of water impacts. | **% internal water extracted for all uses. [IWE% ]** An indication of how much of the nationally available water resource (originating internally or externally such as from inflowing rivers) is already being used. In the Index a high % extraction is taken as an indicator of vulnerability.  **Issues:** Some countries (especially arid) use well over 100% of their internal water as it is either supplemented by desalination for example. These are capped to 100%.  **Scaling :** The base value is taken as 0% (=0) and 100% (=1).  **Cross Correlation :** Capped variable has low correlation with both GDP/Cap or HDI (r2 < 5%) with or without cap. It is in fact little correlated with most other measures.  **Reporting & Time Series :** Data is reported to FAO at 5 yearly intervals. About 40% compliance since 1990 with enough to detect trends in about half the countries.  **Actionable :** Water use includes domestic, industrial and agricultural of which agricultural water use is the dominant water use in most countries. Thus, this is more a measure of the threat to agriculture than the threat to domestic or industrial use.  **Private Sector messages :** This is a comprehensive measure whose value is determined by many different actions and policies. However, many of these actions are appropriate for private sector engagement ranging from water efficiency measures and recycling to desalination.  **Public Sector Messages :** Similar to those described above. Many opportunities for PPPs.  **Alternate or related measures** : Could exclude external water, but this leads to the anomaly of countries such as Zambia, with major river systems flowing through them, show as very water scare. Zambia uses only 2% of its total available water, but this greatly exceeds the amount of internally generated water. Could also include the volume of dam storage to give some idea of buffering capacity.  **Summary :** Solid measure by most criteria and one used in other indices. The main issue is whether it truly does reflect vulnerability. | **% population with access to improved water supply.** [PIW% ****]High % indicates capacity to deliver water to the population and hence lower vulnerability.  **Issues :** Commonly used indicator. However, it saturates very quickly with most countries with a GDP/cap of >$5000 having close to 100% coverage  **Scaling :** Scale 0% as vulnerability of 1 and 100% as 0 vulnerability.  **Cross Correlation :** Highly correlated with HDI (r2 = 65%) and with GDP/cap (r2 = 25% and r2 = 50% with Ln(GDP/cap)). It is also correlated with PIS%.  **Reporting & Time series :**  **Actionable :** Directly actionable although many countries have already reached the highest score.  **Private Sector messages :** An activity with many opportunities for private sector engagement, especially through PPPs.  **Public Sector Messages :**    **Alternate or related measures :**  **Summary :** Good indicator and commonly used in other indicators. |
|  | Qual | **Projected change in temperature** (TMP% ****). Water quality issues rise in warmer conditions causing disease growth & spread; less water for sanitation etc.  **Issues :** This brings the most commonly used climate change indicator into the index. The use of a single measure for an entire country is not very valid, especially for large countries where there are large gradients across the country.  **Scaling :** The base value is taken to be no change and the index is scaled so that the most positive temperature increases (5.5C) score +1 and the lowest (1.5C) score 0.  **Cross Correlation :** Very low  **Reporting & Time Series :** All countries and a single measure.  **Actionable :** Only via mitigation of GHG emissions.  **Private Sector Messages** **:** None {This is a mitigation issue. Obviously the private sector can play a role there but that is not the purpose of this index.}  **Public Sector Messages :** Actionable through mitigation.  **Alternate or related measures :** No obvious alternatives.  **Summary :** A core measure of projected climate change and used as the basis of many projections, indicators etc. | **Existing incidence of water borne diseases (WBD )**. Measured as “Water, sanitation & hygiene deaths per 100'000 children<5 yr” to capture the effects on the most sensitive portion of the population.  **Issues :** There are similar data for all people affected but we have chosen to focus on children as they bear the bulk of the burden. There is obviously an overlap with health measures, but this reflects the strong links between vulnerability arising within the water and health sectors.  **Scaling :** The base values are taken to be no incidence (scoring 0) and 1500 incidences per 100,000 children per year, which will result in a small group of countries scoring close to 1.  **Cross Correlation :** Correlates with r2 of 50% to 60% with PIW% and PIS%. But only 35% with ln(GDP/cap).  **Reporting & Time Series :**  **Actionable :** Directly actionable with many countries having room for improvement. Overall improvement in PIW% and PIS% would improve WBD but there also a range of health related actions available.  **Private Sector Messages** **:** Opportunities for the private sector through a variety of clean water and health interventions. Probably a role for local SMEs in providing improved services to emerging cash economy farmers and middle class.  **Public Sector Messages :**  **Alternate or related measures** : A similar measure is available for the whole population. However, children under 5 account for the largest portion of deaths.  **Summary :** | **% population with access to improved sanitation [PIS% ]**. High % indicates capacity to deliver sanitation and quality water to the population and hence lower vulnerability.  **Issues :** Commonly used indicator. However, it saturates quickly, although slightly slower than PIW%, with most countries with a GDP/cap of >$12000 having close to 100% coverage  **Scaling :** Scale 0% as vulnerability of 1 and 100% as 0 vulnerability.  **Cross Correlation :** Highly correlated with HDI (r2 = 75%) and with GDP/cap (r2 = 35% and r2 = 50% with Ln(GDP/cap)). It is also correlated with PIS% (r2 = 60%) but there is still significant scatter among countries with low values of either variable.  **Reporting & Time Series :**  **Actionable :** Directly actionable although many countries have already reached the highest score.  **Private Sector Messages** **:** An activity with opportunities for private sector engagement, especially through PPPs. More difficult to achieve payments for service than for actions relating to PIW%.  **Public Sector Messages :**  **Alternate or related measures :**  **Summary :** Good indicator despite its high correlation with PIW%. There are differences between countries on the low end of both measures. |
| Food | Quant | **Projected change in agricultural (cereal?) yield** (cf Wheeler) | **% population in rural sector**. These are most sensitive to impacts either through direct food production or loss of livelihood. | **Recent rate of yield increase as ratio of rate of population increase.** If yield increase is not keeping up with population then capacity poor. {What to do for countries with no cereal production?} |
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1. [↑](#footnote-ref-1)