Using the

Climate Vulnerability Index

to assess vulnerability to climate impacts and direct actions for adaptation

The Climate Vulnerability Index approach

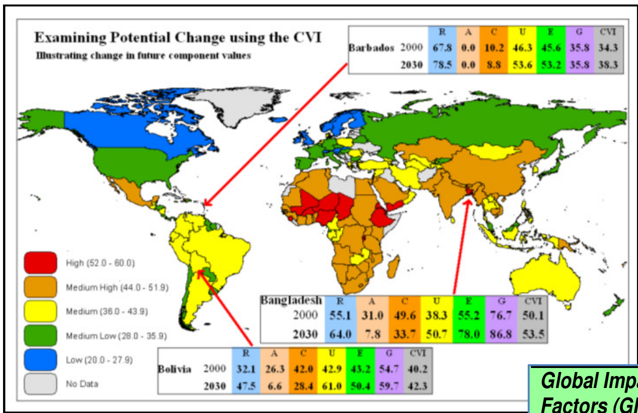
The Climate Vulnerability Index (CVI) is based on a framework which incorporates a wide range of issues. It is a holistic methodology to evaluate how human wellbeing may be influenced by the impact of climate and other global changes on water resources.

The CVI is calculated on the basis of a range of issues grouped together as six ***Global Impact Factors*** **(GIFs).** Each of these is made up of a number of sub-components, or indicators, reflecting specific conditions for the place in question. Where possible, these can be generated from existing data, and both quantitative and qualitative data can be used. All data is normalised on a scale of 1-100 to avoid problems of incommensurability. The results of the analysis are generated as a weighted average of the six ***Global Impact Factors*** (GIFs), based on this 1-100 scale. Current data is used to generate a baseline CVI value, and potential future changes are assessed using scenarios of climate and other forms of global change.

Geospatial variability	Resource quantification	Accessibility and Property Rights	Utilisation and economic efficiency	Capacity of people and institutions	Ecological integrity maintenance

The *Climate Vulnerability Index* can be applied at all scales, and can be useful in the context of transboundary basins, both internationally, and nationally across states.

CVI values across the world:
High values mean high vulnerability



The sub-components of the Global Impact Factors (GIFs)
Each of these ***Global Impact Factors*** is calculated on the basis of measurements from geographical, hydrological, demographic, socio-political or market perspectives. When combined, the resulting composite index provides a baseline to represent the current conditions for the place in question. Scenarios can then be applied to evaluate how each of these GIFs may change in a future period. This provides a representation of how human populations may be influenced by the impacts of climate and other global changes on water resources.

How the CVI is calculated

$$CVI = \frac{r_g G + r_r R + r_a A + r_c C + r_u U + r_e E}{r_g + r_r + r_a + r_c + r_u + r_e}$$

The example provided here illustrates a sub-national level application for Mongolia, where the CVI score is calculated as a composite index for each province.

Incorporating the six components into a holistic framework provides the means for comparative measurement. While the main components of the framework are constant, there is built-in flexibility in the choice of the individual sub-components. These sub-components should be identified after consultation with local stakeholders. Weightings for each indicator within the framework should also be determined by local users rather than scientists, although when comparisons are to be made, it is important that the weightings are consistent.

Data used to calculate the CVI scores for Mongolia

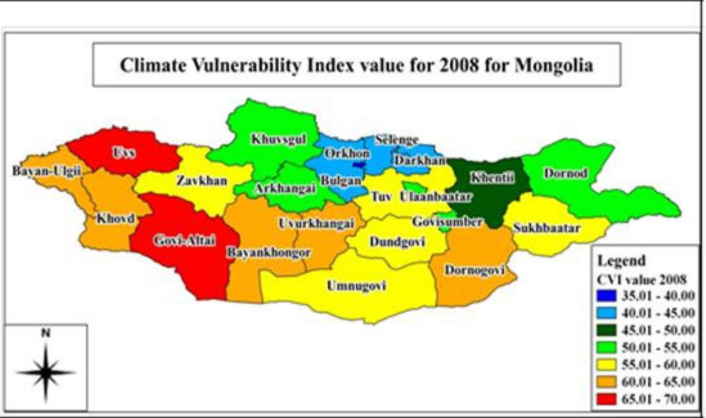
Global Impact Factors (GIFs)	Data used for each indicator	Source data
Geospatial variability (G)	• Isolation from the capital city (food sources) • Human population density • Range in altitude (slope)	• Dist from capital, Mong Rd Atlas 2004 • Statistical yearbook 2008 • Topog Map NASA SRTM 90m DEM data
Resource quantification (R)	• Ave annual precip (mm) * • Total water res per capita (M^3) *	• Statistical yearbook 2008 • Water census 2007, MNET /HDR, 2011
Accessibility and property rights (A)	• Useable water resource per capita (cubic metre) * • Domestic water use (litre per day) *	• Water census 2007, MNET cited in Mongolia HDR, 2011 • Stats yearbook 2008, Basandorj (2011)
Capacity of people and institutions (C)	• Under 5 mortality rate (per 1000 live births) • Tot sch children as % of school age cohort * • GDP per capita (1000 togrogs) *	• The MDGs Implementation, 2009 • National Statistical office, 2008 • Statistical yearbook 2008
Utilisation and econ efficiency (U)	• Econ return on ag water use (togrog) * • Econ return on ind water use (togrog) * • Econ return on mun water use (togrog) *	• Statistical yearbook 2008 • Statistical yearbook 2008 • Statistical yearbook 2008
Ecological integrity maintenance (E)	• Forest area (hectare) * • Pasture-damaged land (in percentages) • Livestock density • Road network (km)	• FAO (2007),Darkhan gov • MNET, 09 Mong HDR, 2011 • National Stats office, 2008 • Mongolian Road Atlas, 2004

Note: Indicators marked with * must be inverted to reflect negative impacts. For example, high rainfall will reduce water vulnerability by increasing water resources and availability, but the high livestock density will increase vulnerability. This means the score for rainfall must be inverted to reflect its impact on the overall CVI score, since high CVI means high vulnerability.

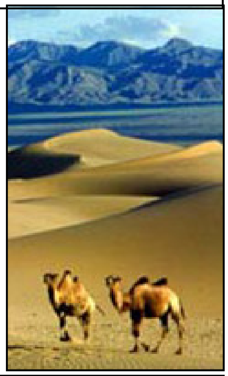
Source: Byambaa, 2012

How conditions in Mongolia may change as a result of climate and other global changes.

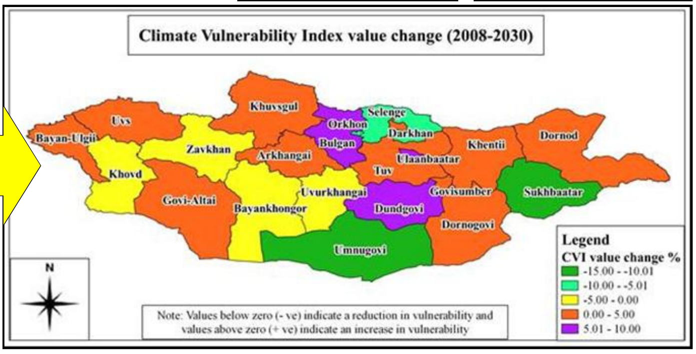
These mapped values of the CVI show that the most vulnerable areas currently are the west and south of the country, while the North and East is less vulnerable. Most vulnerable provinces in 2008 are Uvs and Govi-Altai, while the least vulnerable are Orkhon, and Selenge.



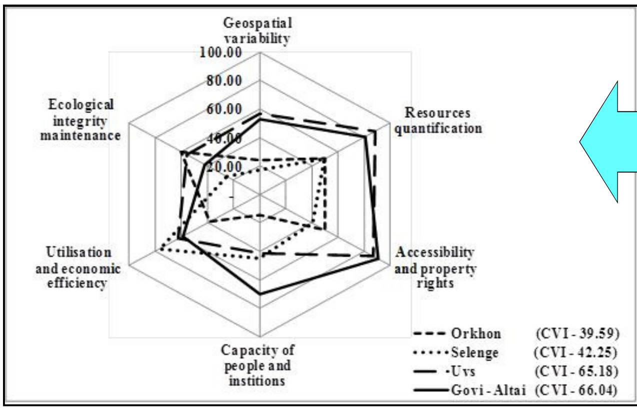
Climate change and development threaten fragile Mongolian ecosystems



This map shows changes in vulnerability at the provincial scale (shown as % change). Dundgovi, Bulgan and Ulaanbaatar will be more vulnerable to changes in water resources, while Sukhbaatar and Umnugovi are likely to be less vulnerable than at present. The main reasons for the changes in this period are due to changes in *Capacity of people and institutions* and *Utilisation and economic efficiency*.



Vulnerability Profiles for selected provinces



Moving away from single numbers
Many people criticise indices for collapsing information into single numbers, but in the CVI this is avoided by presenting the *vulnerability profiles* for the locations in question. This allows the values of individual components to be examined, especially for the purposes of comparison over time or between locations.

Note: In this iteration of the CVI, no attempt is made to take predict floods or other extreme events

Conclusion The CVI provides a powerful technique to systematically express the vulnerability of human communities in relation to water resources. It is a holistic approach which integrates the physical, social, economic and environmental issues. The results are simple to understand – a single number can represent the index for a particular location – but at the same time, the underlying data can be examined, revealing the specific sources of risk being faced in individual locations. Stakeholders should be involved in determining weightings, making the whole assessment process more open and transparent.

The CVI is suitable for examining vulnerability to present pressures, including climate variability, and it can also be used to examine the impacts of climate and other sources of future global change, by combining climate scenarios with expected changes in technological, social, economic, political and environmental conditions. It can help to identify how these changes will vary over both space and time, thus enabling decision makers to make more effective use of resources for adaptation.

Please cite this paper as: Sullivan and Byambaa, (2013) *The application of the Climate Vulnerability Index in Mongolia*. Paper presented to the workshop of climate adaptation, UNECE, Geneva, June 2013.

Contact: Dr Caroline Sullivan, Associate Professor of Environmental Economics and Policy, Southern Cross University, Lismore NSW 2480 Email: caroline.sullivan@scu.edu.au Tel: +61-(02) 66203632

Acknowledgements: This work is an output from research which has been funded by AusAid, Southern Cross University, Australia,

Southern Cross UNIVERSITY