FONDATION POUR LES ETUDES ET RECHERCHES SUR LE DEVELOPPEMENT INTERNATIONAL

A new index of vulnerability to climate change

Who are the most vulnerable developing countries ?

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Why an index of vulnerability to CC ?

There is a growing demand for an index of vulnerability to Climate Change

- Climate Change is a major issue for world economy and policy
  - creation of the Adaptation Fund by the Parties to the Kyoto Protocol of the UN Framework Convention on Climate Change
  - Intergovernmental Panel on Climate Change (IPCC)
- Need of resources to finance adaptation
- Need of criteria for the allocation of these resources (cf. Adaptation Fund declaration)
- One major relevant criterion may be the country specific vulnerability to climate change

So we aim to formulate an appropriate index of vulnerability to climate change that could be available for all the countries concerned and likely to be used as a criterion for allocation of adaptation resources

Our aim is to build a **Physical Vulnerability to Climate Change Index (PVCCI)** as the Economic Vulnerability Index (EVI) designed at the UN.

This index is :

Simple
Measurable
Accurate
Reliable
Timely

The PVCCI focus only on Physical dimension of vulnerability at the country level and could be an original tool to guide the aid for Adaptation to Climate Change

What is vulnerability about?

Three main components of vulnerability : **shock, exposure and resilience** (Fig.1)

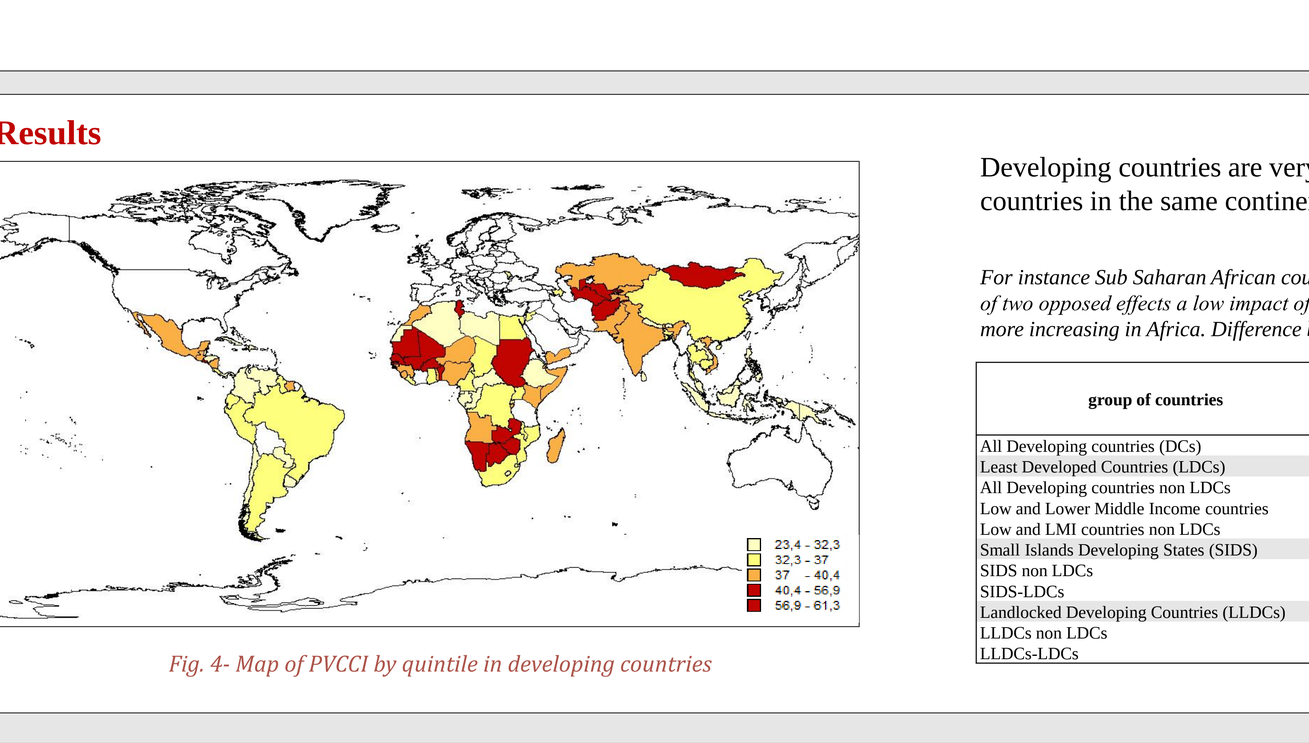
shock: exogenous and often unforeseen factors
exposure : factors on which the direct impact of shocks depends
resilience : capacity to react to the shocks, resilience is mainly related to policy factors

	Chronological analyses		*"Onion" or "Matriochkas" analysis*	*Dichotomic analyses*		*The 'IPCC' analysis*		
	Kelly and Adger (2000)	*O'Brien et al. (2007)*	*Birkmann (2007)*	*Brooks (2003)*	*Adger (2006)*	*Füssel (2010)*		
SHOCKS	End point vulnerability	Outcomes vulnerability	Intrinsic vulnerability	Biophysical Vulnerability	Natural disasters	Regional climate change	Biophysical Impacts	Social Impacts (vulnerability to CC)
EXPOSURE/ SENSITIVITY			Human centred vulnerability			Biophysical sensitivity		
RESILIENCE	Starting point vulnerability	Contextual vulnerability	Multidimensional vulnerability	Social Vulnerability	Entitlements	Socio-economic exposure		
				Social and biophysical vulnerability	Socioecological vulnerability	Socio economic capacity		

: Continuum of vulnerability concepts
: Approximate delimitation
In grey the structural components of vulnerability

Fig. 1-Vulnerability frameworks in the light of the Shocks, Exposure and Resilience definitions

Composition and Calculation



Note: The boxes corresponding to the two last rows of the diagram respectively refer to exposure components *(in italics)* and to size of the shocks components

Fig. 2-Composition of the Physical Vulnerability to Climate Change Index

Components

- ***Risks related to progressive shocks***
  - *Likely impact of the rise of sea level (RSLI)* : the vulnerability of zones likely to be flooded depends on
    - the exposure : the distribution of the heights of arable lands : h_{ij}
    - the shock: the distribution of the likelihood of sea-level rise in *t* years: s_{ijt}

$$SLR_i = \int^{t}\int^{j} \frac{h_{ij}}{(1+r)^t} \times s_{ijt}$$

  - *Over-aridity and desertification impact (OADI)* :
    - the exposure: proportion of arid areas
    - the shock : trend value in rainfalls and temperatures (β)
- ***Risks related to intensification of recurrent shocks***
  - *the exposure: average frequency of shocks in rainfalls and temperatures (A)*
  - *the shock : trend in the size of shocks as a proxy of the intensity of future shocks (B)*

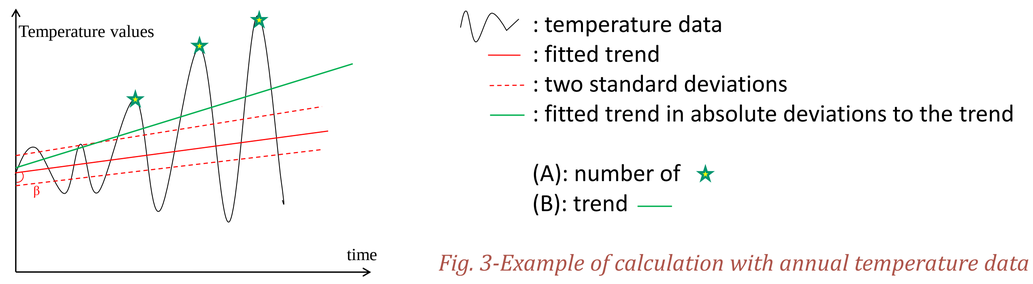


Fig. 3-Example of calculation with annual temperature data

Data Base

Dasgupta et al. (2009)
World Resources Institute (1999) et UNEP /Global Resource Information Database (UNEP/GRID)
Willmott et al. (1995), Legates et al. (1990a 1990b), Université de Delaware

Sensitivity tests

Aggregation average (quadratic, arithmetic and geographic).
Starting date of calculation for the trend (1950-1970) and non linear trend
2 methods for instability: number of shocks and sum of absolute deviation to the trend

Results

Fig. 4- Map of PVCCI by quintile in developing countries

Developing countries are very vulnerable to climate change but there is an important heterogeneity of vulnerability between countries in the same continent or in the same group of countries (Fig. 4 and Tab.1).

For instance Sub Saharan African countries evidence a higher average PVCCI than others DCs : the level of the risk associated to progressive shocks index is a result of two opposed effects a low impact of the sea level rise in Africa : the component "increasing aridity" more important for African DCs and the trend in temperature is more increasing in Africa. Difference between DCs and African DCs is important and non ambiguous for the impact of the increasing recurrent shocks

group of countries	PCCVI arithmetic average				PERMANENT SHOCKS				RECURRENT SHOCKS			
	Nb of countries	Mean	Median	Standard Deviation	Nb of countries	Mean	Median	Standard Deviation	Nb of countries	Mean	Median	Standard Deviation
All Developing countries (DCs)	116	36.43	35.89	6.77	116	25.27	22.98	11.60	142	46.72	45.75	7.48
Least Developed Countries (LDCs)	46	38.28	38.38	8.04	46	25.62	20.19	14.62	49	51.03	51.02	7.58
All Developing countries non LDCs	72	35.48	34.77	6.30	72	25.47	24.92	10.49	95	44.56	44.60	6.40
Low and Lower Middle Income countries	84	37.64	37.21	7.13	84	26.32	23.70	13.00	95	48.54	48.92	7.50
Low and LMI countries non LDCs	39	36.66	36.72	5.92	39	26.80	26.57	10.95	47	45.85	45.40	6.42
Small Islands Developing States (SIDS)	29	38.00	34.60	9.42	29	28.47	24.19	16.66	31	46.41	44.86	6.85
SIDS non LDCs	18	35.98	34.29	7.51	18	26.63	24.50	12.73	20	45.04	44.56	4.73
SIDS-LDCs	11	40.19	38.67	11.85	11	31.49	20.45	22.04	11	48.89	49.75	9.37
Landlocked Developing Countries (LLDCs)	27	37.14	36.87	6.24	27	26.93	30.08	11.55	29	47.02	48.79	8.12
LLDCs non LDCs	11	39.43	40.09	4.96	11	35.03	35.33	6.94	13	43.64	42.97	6.41
LLDCs-LDCs	16	35.56	33.52	6.67	16	21.36	16.91	10.86	16	49.76	49.45	8.50

Tab. 1- PVCCI by group of countries

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