



Vulnerability of LDCs to Climate Change

Lessons from a New Indicator of Physical Vulnerability to Climate Change

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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 and 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
- Special interest of such an index for LDCs and IPoA
 - LDCs (not responsible for climate change) often considered as highly vulnerable to Climate Change, without quantitative assessment
 - * Concern about the special vulnerability to climate to climate change of the recently graduating countries

Aim of the paper

Assessing the vulnerability of LDCs to climate change

- First setting the issue in the framework of the studies of the various vulnerabilities of LDCs and the IPoA,
- Then we present a new index of vulnerability to climate change, that could be available for all the countries concerned: it is an index of *physical* vulnerability to climate change (PVCCI), as the Economic Vulnerability Index (EVI) is an index of *structural* economic vulnerability.
- The results obtained allow us to examine the vulnerability of LDCs to climate change, to compare to that of other groups of countries and also to evidence the various kinds of vulnerability of LDCs to climate change

About vulnerability concepts applied to LDCs and their relevance to monitor IPoA

Economic vulnerability and its components

general vulnerability vs structural vulnerability

- Vulnerability is the risk to be affected by exogenous shocks, either at the micro or (here) macro level.
- Vulnerability has 3 components: exposure to shocks, size of shocks, capacity to react or resilience
- Exposure and likelihood of shocks are mainly structural, resilience is more dependent on present policy

Vulnerability as a criterion for the identification of LDCs

Introduced in 2000 as a *major structural handicap to growth*,

As such structural, as depending on durable factors, not on present will or policy of countries

EVI relies of indicators of exposure and (recurrent) shocks

Structural factors of *resilience left aside*, well captured by GNIpc and HAI, that with EVI are used as complementary criteria for the identification of LDCs. Including them in the vulnerability index would blur the specificity of the vulnerability concept

No relevant measure of structural resilience

Vulnerability of LDCs and their resilience to global crisis

- Structural vulnerability, as captured by EVI, refers to the consequences (on growth) of *recurrent shocks*, specific to each country (idiosyncratic), rather than to the impact of a global or common shock, such as the global crisis
- Need to have special analyses of the consequences of the global crisis in LDCs, as done by DB/SD at CPD or CA at Ferdi. Specific resilience of LDCs to the crisis seemingly better than expected

Structural economic vulnerability and LDCs from state fragility

- 2 different concepts, leading to separate LDCs and fragile states (FS) , with a risk for the attention given to LDCs (Busan: LDCs vanishes...)
- State fragility designed and identified only from present policy and institutional factors: lack of state capacity, political will and legitimacy (many changing definitions)
- Structural economic vulnerability designed from factors (exogenous shocks and exposure) independent of policy
- But structural vulnerability influences state fragility,
- And many LDCs are also FS (most are or have been so)

Economic vulnerability and vulnerability to climate change

- Vulnerability to *climate* already taken into account through several components of EVI (population affected by natural disasters, instability of agricultural production), and now more specifically by the risk to be flooded due to the sea level rise
- But vulnerability to climate change differs from the economic vulnerability by its nature (more physical) and time horizon (longer) : it reflects a long term *risk of change in geo-physical conditions*, not a structural handicap to economic growth in medium term
- And it is vulnerability to only one (major) environmental factor

Designing an Index of Physical Vulnerability to Climate Change Index (PVCCI)

Existing indices on climate change and their limits

- Many existing indices related to vulnerability to CC
 - Vulnerability resilience Moss et al (2001)
 - Environmental Sustainability Index Easty et al. (2005)
 - Dimensions of vulnerability Downing et al (1995)
 - Index of Human Insecurity Lonergan et al. (1999)
 - Predictive Indicators of vulnerability Brooks et al. (2005)
 - Global distribution of vulnerability Yohe et al. (2006)
 - EVI CC Kaly et al.(2004)
 - The Index of socioclimatic exposure Diffenbaugh et al. (2007)
 - Climate Change Index (CCI) Baettig et al (2007)
 - National Climate Change Index Giorgi (2006)

- Lot of studies about these indices: rank comparison, analysis of sensibility, methods

Eriksen and Kelly (2007) ; Füssel (2009) ; Gall (2007) ; Eakin and Luers (2006)

Two kinds of issues raised by present indices

- Usual technical problems
 - scale,
 - aggregation,
 - sensitivity to proxy ,
 - robustness,
 - transparency
- More specifically and important, a design problem
 - theoretical background,
 - policy relevance

What we need

- A physical vulnerability index focused on the structural dimension of vulnerability, allowing us
 - To present an accurate definition and precise components
 - To provide an index only based on exogenous elements
 - To obtain a more synthetic index than the “overall vulnerability indices” but reliable and relevant
- A country level analysis consistent with the need of criteria for the allocation of the adaptation resources (as already discussed for the EVI and ODA allocation)
- A long term time scale analysis for the PVCCI , unlike the EVI,
- A simple and clear framework of aggregation , as done for EVI

Components of the Index of Physical Vulnerability to Climate Change

- ***Risk 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}

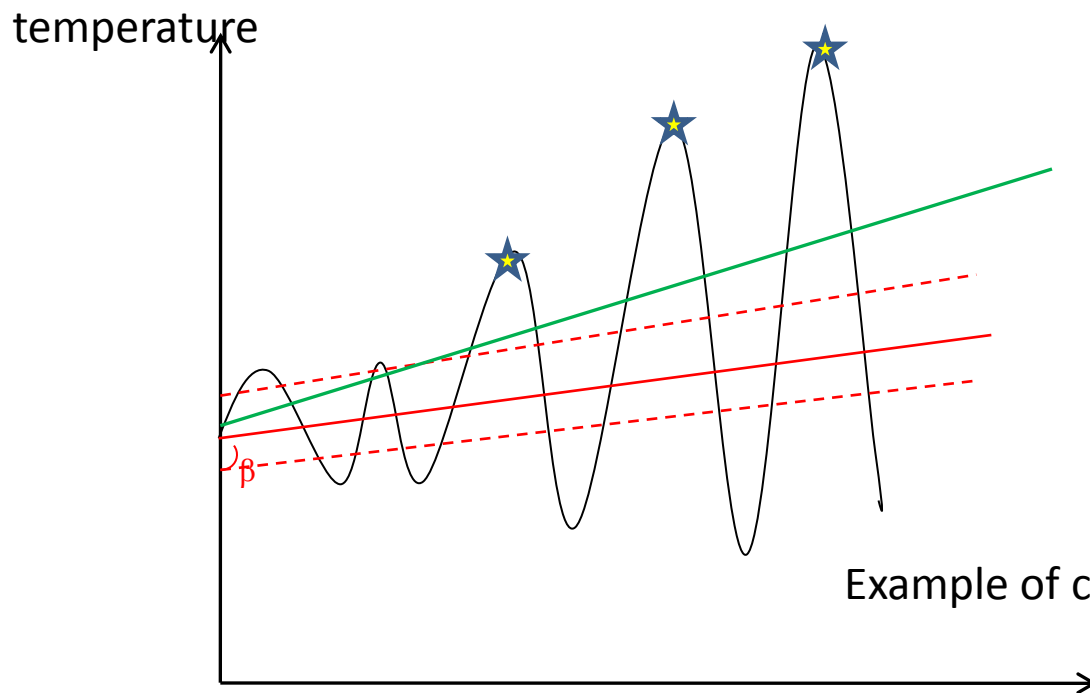
$$SLR_i = \int \int \frac{h_{ij}}{(1+r)^t} \times s_{ijt}$$


- *Over-aridity and desertification impact (OADI)* :

- the exposure: proportion of arid areas
- the shock : trend value in rainfalls and temperatures (β)

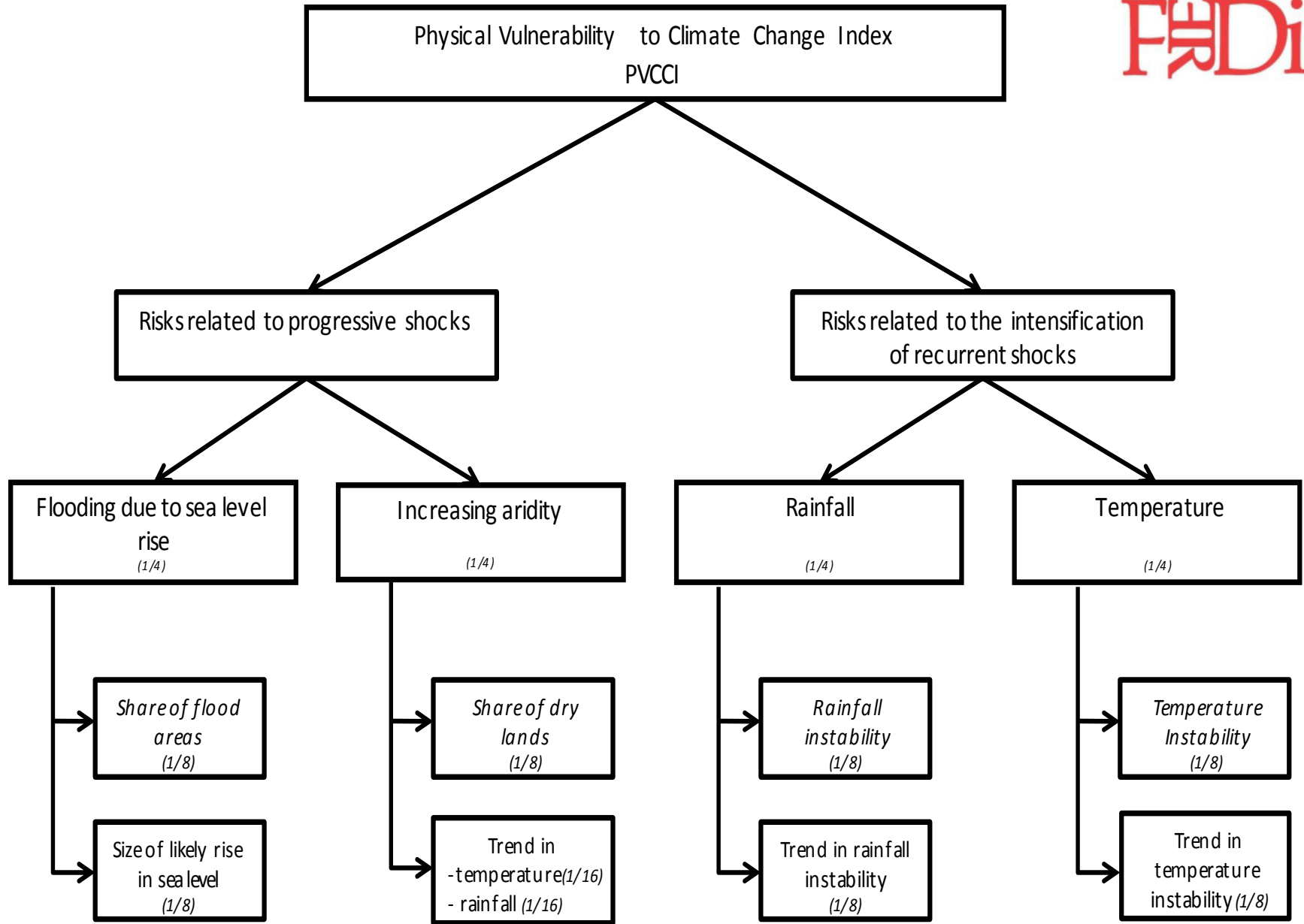
- **Risks related to intensification of recurrent shocks**

- *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)*



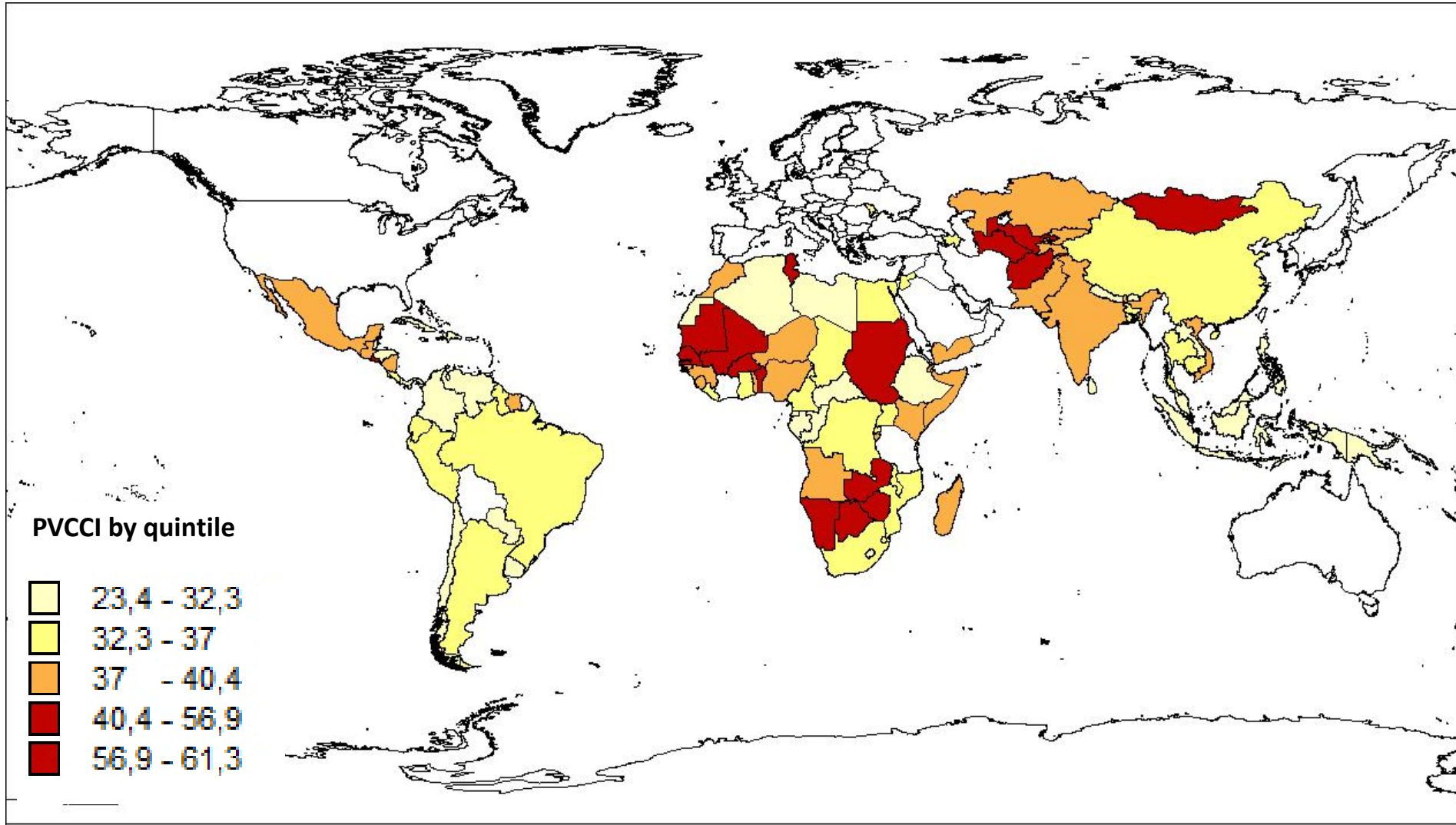
(A): number of 
 (B): trend **B**

Example of calculation with annual temperature data



The vulnerability to climate change of LDCs, as evidenced by the Index

PVCCI in developing countries



Components of PVCCI by group of countries



| group of countries | PVCCI | | | | PROGRESSIVE 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 | 42,10 | 41,62 | 7,66 | 116 | 32,43 | 28,87 | 14,83 | 142 | 47,38 | 46,10 | 7,64 |
| Least Developed Countries (LDCs) | 46 | 44,61 | 44,17 | 8,33 | 46 | 33,20 | 26,32 | 16,84 | 49 | 51,82 | 51,71 | 7,65 |
| All Developing countries non LDCs | 72 | 40,79 | 39,34 | 7,37 | 72 | 32,51 | 29,49 | 14,33 | 95 | 45,14 | 44,76 | 6,60 |
| Low and Lower Middle Income countries | 84 | 43,62 | 43,72 | 7,81 | 84 | 33,98 | 30,43 | 15,82 | 95 | 49,19 | 49,21 | 7,66 |
| Low and LMI countries non LDCs | 39 | 42,21 | 41,87 | 7,08 | 39 | 34,49 | 32,18 | 14,72 | 47 | 46,35 | 45,52 | 6,61 |
| Small Islands Developing States (SIDS) | 29 | 42 | 37,14 | 10,33 | 29 | 32 | 24,93 | 18,76 | 31 | 47 | 45,92 | 7,17 |
| SIDS non LDCs | 18 | 38,82 | 36,86 | 7,98 | 18 | 28,23 | 24,41 | 14,70 | 20 | 45,60 | 45,47 | 4,88 |
| SIDS-LDCs | 11 | 46,60 | 45,34 | 12,21 | 11 | 38,55 | 28,85 | 23,36 | 11 | 50,49 | 49,84 | 9,59 |
| Landlocked Developing Countries (LLDCs) | 27 | 44,51 | 45,75 | 7,33 | 27 | 38,07 | 42,54 | 16,34 | 29 | 47,52 | 48,97 | 8,26 |
| LLDCs non LDCs | 11 | 47,30 | 48,45 | 6,08 | 11 | 49,54 | 49,96 | 9,81 | 13 | 44,02 | 42,99 | 6,43 |
| LLDCs-LDCs | 16 | 42,59 | 40,31 | 7,67 | 16 | 30,19 | 23,92 | 15,36 | 16 | 50,35 | 49,66 | 8,66 |
| African Developing countries | 44 | 44,74 | 44,98 | 6,63 | 43 | 33,99 | 32,66 | 12,94 | 47 | 51,84 | 51,04 | 7,17 |
| African LDCs | 30 | 44,97 | 45,52 | 6,35 | 30 | 32,71 | 27,66 | 12,72 | 32 | 53,15 | 53,11 | 7,24 |
| African Low and LMI countries | 37 | 44,39 | 44,98 | 6,09 | 37 | 33,05 | 29,60 | 12,22 | 40 | 51,99 | 51,38 | 7,18 |

- A high average level of vulnerability to climate change in LDCs
 - Vulnerability of LDCs higher than that of other developing countries, even SIDS and LLDCs
 - Not so much due to the level of progressive shocks components, set up mainly by SIDS-LDCs than to the increasing level of recurrent shocks, driven by African LDCs
 - Suggesting the heterogeneity of the sources of vulnerability in LDCs

- Various major sources of vulnerability to climate change in LDCs

| Name of category | PROGRESSIVE SHOCKS | | INCREASING RECURRENT SHOCKS | | Example of countries concerned |
|--|--------------------|--------------------|-----------------------------|--------------------|---|
| | Sea level rise | Increasing aridity | Rainfall shocks | Temperature shocks | |
| Global High Vulnerability | +++ | | +++ | | Senegal, Gambia |
| Vulnerability to recurrent shocks | | | +++ | | Burundi, Sierra Leone, Zambia |
| Vulnerability to progressive shocks | +++ | | | | Benin |
| Vulnerability to sea level rise | +++ | | | | Kiribati, Maldives, Tuvalu, Bangladesh |
| Vulnerability to increasing aridity | | +++ | | | Burkina Faso, Afghanistan |
| Vulnerability to increasing rainfall shocks | | | +++ | | Bangladesh, Myanmar, Guinea-Bissau, Angola, Sao Tome and Principe |
| Vulnerability to increasing temperature shocks | | | | +++ | Timor-Leste, Comoros, Rwanda |

- Structural economic vulnerability and physical vulnerability to Climate Change of some LDCs : ranking compared, over 113 developing countries

| | | EVI | |
|-------|-----------------|--|------------------------------------|
| | | Very high rank | Rather low rank |
| PVCCI | Very high rank | Tuvalu Kiribati Equatoriale Guinea | Bangladesh Burkina Faso Mali |
| | Rather low rank | <i>Cape Verde</i> CAR <i>Vanuatu</i> | |

NB : The average of the absolute differences in ranks, is around 35 for all developing countries and around the same for 46 LDCs, evidencing a higher dispersion for the latter.

Conclusion

- The Physical Vulnerability to Climate Change of LDCs has been assessed through a new index
 - focused only on the structural/physical dimension of vulnerability
 - relying on the main physical trends linked to climate change (shocks)
 - taking into account the initial conditions specific to each country (exposure)
- Results for LDCs
 - higher PVCCI for LDCs than for the other developing countries
 - significant heterogeneity in the kind of vulnerability among LDCs
- Policy use: an index likely
 - to be relevant for resources allocation
 - to detect various profiles of vulnerability to climate change and so help to design appropriate adaptation policies