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Facing Climate Change in the LDCs: How to Implement the Istanbul Programme of Action

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Facing Climate Change in the LDCs : How to Implement the Istanbul Programme of Action

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Executive Summary

The climate change issue is briefly considered in the chapter 4 "Priority areas for actions", section F «Multiple crises and other emerging challenges» of the Istanbul Declaration. In this section, climate change is examined with environmental sustainability and besides economic shocks and disaster risk reduction. The monitoring of this section about climate change is fairly complex, since the related actions to be taken do not refer to monitoring indicators, measurable and observable. In order to monitor these actions we propose to first identify through an indicator of physical vulnerability to climate change the level and type of vulnerability to climate change of the LDCs. Then, we evaluate two types of actions recommended by the IPoA: establishment of NAPAs and the LDC Fund orientation. The first part of the paper evidences the high level of vulnerability of the LDCs and heterogeneous profiles of vulnerability to climate change among them. The second part is an assessment of the actions recommended by the IPoA for the adaptation to climate change considering the need of the countries as identified by the index.

The substance of this chapter have been presented at the LDC IV Monitor Expert group meetings in Dhaka (September 2012) and Dar EGM, Dar Es Salaam (February 2013) and London (June 2013), where authors benefited from useful comments supplemented by relevant remarks of external referees: Y. Sokona, South Center, Nina Becker and Tom Mitchell, ODI. All are acknowledged, without been responsible for any opinion expressed or possible errors in the present paper.

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1. Introduction

The international community has recognized that climate change has an unbalanced impact on developing countries and poor populations. The Fourth Assessment Report of the IPCC establishes that developing countries are expected to suffer the most from the negative impacts of climate change. As their economies strongly rely on climate-sensitive sectors (noticeably agriculture) and are particularly exposed to the impacts of climate change due to their geographic and climatic conditions, these countries are likely to be the first victims of the climate change. Moreover, they display often a low adaptation capacity due to institutional weaknesses in particular in the financial sector. In many developing countries, climate change increases stresses from climate variability (IPCC 2007a).

The Least Developed Countries (LDCs) are characterized by a low income per capita and structural handicaps to growth, in particular high economic vulnerability. As climate change exacerbates the existing economic vulnerabilities, LDCs are expected to be the most affected among the developing countries. The Declaration of Istanbul (May 2011) states that *"Climate change disproportionately affects the socio-economic development of least developed countries, considering that they have contributed least to the problem, and also threatens to reverse some of the development gains that have been achieved to date"* (Paragraph 99).

The Istanbul Program of Action (IPoA), considered climate change and environmental sustainability among the "priority area of action" (chapter 4 of the declaration) in the section F of this chapter under the heading "Multiple crises and other emerging challenges", this section containing two other major issues: economic shocks and disaster risk reduction. Finally 4 pages from out of 74 dedicated to the priority area are related to climate change and environment sustainability as well. Thus, the place of climate change issue in the declaration are a rather limited visibility also the recommendations made in the section are highly important for the international community. One of the main goals as stated at the beginning of the section F (paragraph 94) is to *"Strengthen least developed countries' ability to withstand and overcome the adverse effects of climate change, enhance sustainable growth and protect biodiversity"*. Among the actions to be taken by the least developed countries (seven actions) and the development partners (nine actions) those related to climate change are essentially focused on adaptation (cf. Table A1 in Annex). However the monitoring of the recommendations about climate change section is rather difficult since the actions of the IPoA for this topic do not refer to monitoring indicators, measurable and observable.

The fact that some countries which are not the most responsible for climate change suffer disproportionally from climate change is not debated. Neither is the need for additional resources to finance adaptation. But research is needed to evaluate the extent to which LDCs are affected and are vulnerable to climate change since the impacts of climate change widely vary across geographical regions (IPCC 2007a). As characteristics of each country are heterogeneous, the vulnerability to climate change to each country is also variable. To monitor how IPoA is addressing the issue, we propose to first identify through an indicator of physical vulnerability to climate

change the level and type of vulnerability to climate change of the LDCs. This first step (section 2) is needed to obtain a quantitative and objective index of vulnerability which could be used to monitor the actions recommended by the IPoA. Revealing the overall characteristics of the LDCs in terms of vulnerability as well as their heterogeneity in the shapes of vulnerability to climate change and consequently in the required adaptation policies constitute the first step of this paper. We highlight the highest vulnerability of LDCs to climate change compared to other developing countries and we analyze the heterogeneity of their vulnerability profiles.

If the vulnerability of LDCs to climate change is high, it requires resources for adaptation as it is claimed by the IPoA (both for adaptation and mitigation): *"Least developed countries need additional, predictable and adequate technical and financial support for climate change adaptation and mitigation in line with international commitments. Progress has been achieved in this regard under the United Nations Framework Convention on Climate Change (UNFCCC) through the adoption of decisions at the sixteenth Conference of the Parties to the Convention in Cancun, Mexico, in 2010."* We assess the implementation of IPoA related to climate change with regard to an appropriate index of vulnerability. Then, the second part of the paper (section 3) aims at monitoring main actions taken for helping LDCs to face climate change. As these countries are less responsible to the phenomenon than they are victims, we focus on the adaptation challenge underlined in the IPoA. So, we examine what has been the international support to the adaptation policies, in particular through the LDC Fund, noticeably in the implementation of National Adaptation Plans of Actions (NAPAs) of the LDCs.

Thus, the first part of the paper studies to what extent and how LDCs are vulnerable to climate change by using a new index of physical vulnerability to climate change. In the second part, we study the extent to which resources and climate policies implemented since 2011 meet the guidelines of the IPoA and are consistent with the assessment of vulnerability made in the previous section.

2. To what extent are LDCs particularly vulnerable to climate change? A preliminary to the assessment of the IPoA as it regards adaptation

It seems to be recognized that the the LDCs are strongly victims of climate change.. However this view generally does not relies on a quantitative evaluation. Here, we show these countries are vulnerable to climate change, using a physical vulnerability index , independent of policies. The idea of an assessment of the physical vulnerability is consistent with common vulnerability frameworks as explained in Guillaumont and Simonet (2011a) and with also the SREX (2012) conceptual framework, but it involves to make a systematic distinction between what is or is not independent of countries policy to be more accurate with the development challenges. This section relies on a new index of physical vulnerability to climate change, as presented by Guillaumont and Simonet (2011a) and already applied to differenciate African countries from other developing countries (Guillaumont and Simonet 2011b). The index qualifies the vulnerability of the LDCs and underlines the heterogeneity of the vulnerability among them.

2.1. Composition

The expanding literature on the economic consequences of climate change lead us to distinguish between two kinds of physical impacts of climate change and related risks: *risks of progressive shocks* and *risks of increasing recurrent shocks*.

Starting from this distinction between the risk of progressive shocks and the risk of increasing intensity of the shocks, we identify reliable indicators to compose an index of physical vulnerability to climate change. Differing from other attempts to assess vulnerability to climate change, our assessment only considers the expected impact of climate change on physical variables[1]. These variables are of course likely to have socio-economic consequences, but they are not socio-economic variables. The rationale behind such an index is twofold. First, using physical indicators (e.g. sea level, rainfall, temperature) means using only objective or neutral data and avoiding any reference to indicators partly influenced by policy or resilience factors: this is abolutely needed if index is to be used as a criterion for the allocation of international ressources, as explained below. Second, this physical index does not involve an assessment of the expected impact of climate change on variables such as health and agriculture, which unavoidably is highly uncertain and debatable. The physical index can simply be seen as an intermediary step to assess the link between climate change and these economic variables.

The risks related to *progressive shocks* (or continuous hazard) refer to possible persistent geophysical consequences of climate change at the country level. The two main kinds of such risks, as identified in the literature, are a rise of sea level, possibly leading to flood, and an increase of aridity, possibly leading to desertification. The vulnerability of a country to the sea level rise is evidenced by the risk of this country to be flooded. Its assessment involves making a distinction between the likely size of this shock (rise of the sea level) and the exposure to this shock (altitude). The indicator of the risk of increasing aridity and desertification relies on the same distinction between the exposure to shocks and the size of shocks. The exposure can here be proxied by the actual share of dry lands in the country (or the actual average level of rainfall in the country). The higher the share of dry lands (or the lower the rainfall level), the higher is the risk to be affected. As for the size of the shocks, it has appeared relevant to retain the trend in the annual average temperature in each country (over the last decades). A complementary proxy of this shock measurement can also be found in a decreasing trend of the average rainfall level.

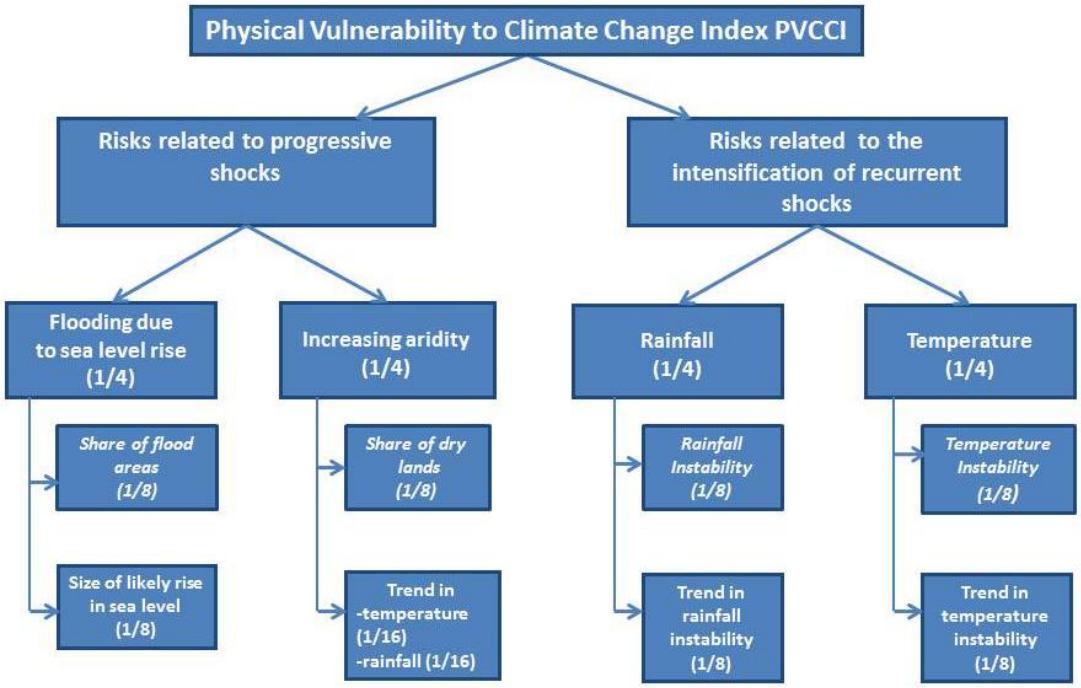
The risks of *an increaing intensity of recurrent shocks* generated by climate change occur through more frequent or more acute natural shocks on rainfall and temperature (such as droughts, typhoons, floods,…). The vulnerability to rainfall and temperature shocks has again two main components, corresponding to the previous distinction between exposure and shocks. The exposure component is related to the size and frequency of the shocks during past years (or the

[1] Among various instability indices, Notre Dame Global Adaptation Institute Index (ND-GAIN 2013), the Climate Vulnerability Monitor of DARA (2012) and the vulnerability to climate change assessment established by Wheeler (2011) are set up to be operational, but they mix assessment of the 'structural' or physical vulnerability to climate change and the overall vulnerability, which also depends on the country's policies. As such, they seem less appropriate.

past rainfall and temperature instabilities). The shock component, here captures a risk of an increase of the size of the recurrent shocks as a result of climate change, and is more forward-looking; it is reflected by the trend in the frequency and size of the past shocks (or the trends in rainfall and temperature instabilities), supposing that these trends are determined by climate change and are likely to go on in the future. These two components are measured by the same way for rainfall and temperature. Each of the eight components is normalized following the min-max method. As for averaging, equal weights are given to the two main categories of shocks, then to the four main components and finally to the eight sub-components. The usual practice is to calculate an arithmetic average. However, any of the main components may be of crucial importance for a country, more or less independently from the level of the other components. It is then relevant to use an averaging method reflecting this limited substitutability between components, either by a quadratic average of the components or by a reversed geometric average (as discussed in Guillaumont, 2009a and 2009b).

The structure of the index is presented in Figure 1, which distinguishes risks related to progressive shocks and risks related to more intense recurrent shocks, both considered as resulting from climate change. The progressive shocks cover those due to (i) the sea level rise and (ii) the trend in average rainfall and temperature. The intensification of recurrent shocks corresponds to (iii) rainfall shocks and (iv) temperature shocks. For each of these four main components, an exposure index (in italics) and a shocks index have been computed.

FIG. 1-Composition of the Physical Vulnerability to Climate Change Index



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

The physical vulnerability to climate change index thus gathers eight sub-components into four components reflecting two kinds of shocks (progressive ones and increasing recurrent ones), following a unified framework.

The companion database gives the measure of each component and sub-component, allowing one to use his own averaging method or to use each separately.Data are obtained from the works of Dasgupta and al. (2009) for the calculation of exposure to rise of sea level. Rainfall and temperature data come from Global Air Temperature and Precipitation: Gridded Monthly and Annual Time Series (Version 2.01, Cort J. Willmott and Kenji Matsuura, University of Delaware). Data on the exposure of dry lands come from the United Nations Development Programm/ Office to Combat Desertification and Drought UNDP/UNSO (1999), and from the United Nations Environment Program/Global Resource Information Database (UNEP/GRID 1991).They are available on the World Resources Institute website. The physical vulnerability to climate change index has been calculated from data beginning in 1950, covering the last sixty years.

The PVCCI still meets some limitations and can of course be refined. For instance, it presently fails to take into account the vulnerability to melting snow and glaciers, which is a major issue for countries such as Bhutan. However, this can be remedied by not limiting the risk of flooding to that resulting from the sea level rise. Anyway it seems that this is the first index allowing one to compare the vulnerability to climate change for most countries from only physical data, reflecting major identified likely impacts of climate change in developing countries.

2.2. LDCs, physically more vulnerable to climate change than other developing countries

As it is recalled in the IPoA, the population of LDCs is highly vulnerable to climate change.. Referring to our index of physical vulnerability to climate change, we indeed evidence a high vulnerability to climate change. The reasons behind this vulnerability are revealed through the lens of the components of the index. While the index does not incorporate socio-economic factors, it is useful to have in mind the socio-economic background of climatic vulnerability.

Four main issues related to the high vulnerability of developing countries to climate change should be taken into consideration.

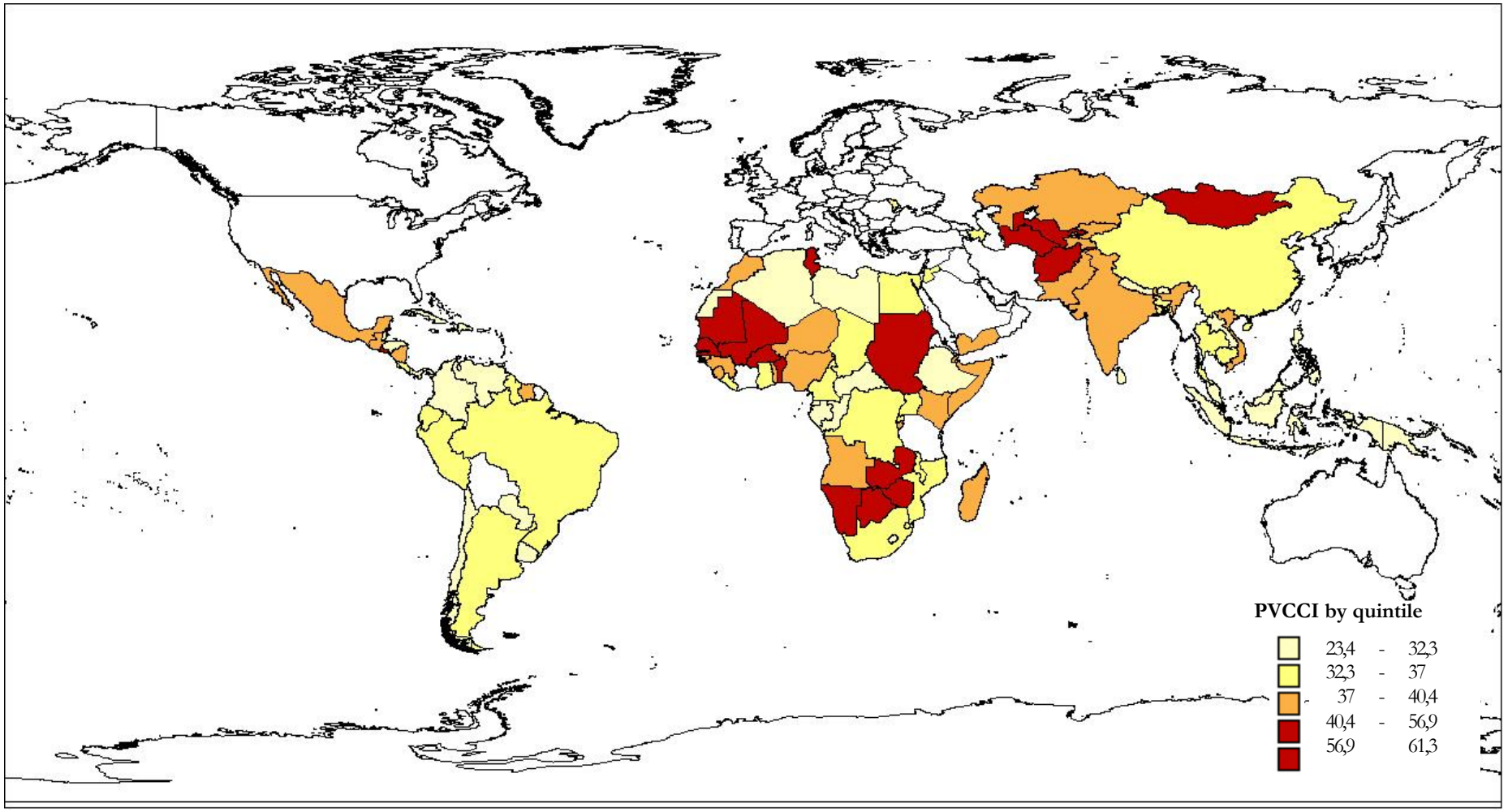
First, most of these countries, and in particular African and South Asian economies, are very dependent on climate sensitive sectors such as agriculture, forestry and fishery. Agricultural production in many of these countries and regions is likely to be severely affected by climate change. Many African countries are classified as arid or semi-arid, and climate change is likely to reduce the length of the growing season in these regions. Projected reductions of yields could be as much as 50% by 2020 in some countries (IPCC 2007a, chapter 9). The small-scale poor farmers will probably be the most affected. This effect on agriculture would result both in a lower economic growth, and in a lower food security.

Second, extreme events, such as droughts or floods, have major effects on developing countries. The impact of droughts has been thoroughly documented in numerous studies, which show their economic and social consequences, including on migration (World Bank 2010). During the mid-1980s, the economic losses due to droughts were estimated at several hundred million U.S. dollars (Tarhule and Lamb 2003). Droughts are prevalent in the Sahel, the Horn of Africa and Southern Africa. Some African and Asian countries also experience flood events, which can result in a significant economic deprivation (Mirza 2003).

Third, climate change exacerbates the water stress currently faced by some countries. It also generates water stress in countries where this problem did not previously exist.

Finally, the sea level rise strongly affects small poor islands, often considered as particularly vulnerable. SIDS and most Least Developed Countries islands are those most exposed to this trend.

FIG. 2-PVCCI for Developing Countries



Differences by category

The index of vulnerability to climate change presents a higher level for LDCs compared to the other developing countries. The LDCs are more exposed to climate change impacts and are suffering from more important shocks due to climate change. The high vulnerability of the category is due to various impacts assessed by the components of the index. This situation of extrem vulnerability of the category reveals heterogenous profiles of vulnerability among the group.

In the Table 1 (completed by the table A2 in Annex), we compare the LDCs category to other developing countries (low income and lower middle income) or other geographical groups of developing countries (landlocked countries and small islands). The LDCs are more vulnerable than other groups of countries on average (44.6 compare to 40.8 for developping countries non LDCs). The component "risk of progressive shocks" presents almost the same value for the category than for the other countries (33.2 to 32.5 in other developing countries). The risk of increasing recurrent shocks is higher than for other developing countries (54.1 vs 51.8)[2].

Within the LDC category, the LDC-SIDS countries seem most vulnerable (46.6), with also the highest standard deviation. This sub-category presents an average level of vulnerability higher than all the SIDS group and the LDCs category. SIDS and particularly SIDS-LDCs are mostly vulnerable to progressive shocks (and more precisely to sea level rise). The LLDC-LDCs category presents a high level of vulnerability but this vulnerability is not higher than the vulnerability of LLDC which is very important (LLDC-LDCs category is more vulnerable to risk of increasing recurrent shocks, but LLDCs non LDCs are particularly vulnerable to the risk of desertification of the progressive shocks component).

Differences by region

In each world region, LDCs are more vulnerable than developing countries of the same region. The LDCs of South Asia are the most vulnerable to climate change (45.29). The second category of vulnerable LDCs are African LDCs. The category of LDCs in South Asia and the Pacific displays the highest standard deviations (more than 12 points), a result reflecting a wide range of vulnerability profiles in these two groups.

LDCs exhibit a level of vulnerability to progressive shocks almost identical to that of other developing countries in their region. Except for the Pacific where LDCs are more vulnerable to progressive shocks than other developing countries. On average, LDCs are more vulnerable than developing countries to the risk of increasing recurrent shocks. The Middle East LDCs and South Asian LDCs are the most vulnerable to progressive shocks (37.9 and 35.3). African LDCs and East Asian and Pacific LDCs are the most vulnerable to the increase of recurrent shocks (53.15 and 50.5).

2 As the LDCs category includes both several landlocked and small island countries, the component "risk of sea level rise" has the highest level of standard deviation.

2.3. Heterogeneity of physical vulnerability among LDCs.

Since the index is estimated country by country, it exhibits a large heterogeneity in the levels and the types of vulnerability among countries as highlighted by Figure 2. Its measurement, while showing a high average vulnerability to climate change for LDCs, also shows levels very uneven across LDCs, and resulting from various components (see Annex 2.3).

The four most vulnerable LDCs with regard to the PCCVI are Gambia, Kiribati, Senegal and Tuvalu, as was Maldives a former LDC. These countries present a high level of overall physical vulnerability, generally due to a high level of several components of the index.

As for vulnerability to progressive shocks, the level of this component (due to two sub-components, sea level rise and increase in aridity) is for some LDCs countries (Tuvalu, Afghanistan, Kiribati Maldives, Senegal) at the highest level in the world. This high level of vulnerability to progressive shocks is for the LDCs due to sea level rise, noticeably for SIDS-LDCs, and due to the risk of over aridity, noticeably for LLDC-LDCs located in desert area. For instance, Kiribati and Tuvalu are with Maldives the countries of the world the most exposed to sea level rise and Afghanistan is particularly exposed to the risk of over aridity. The ranking of African LDCs vulnerable to aridification is the highest in the world, along with some Central Asia countries (e.g. Afghanistan, Turkmenistan). Some LDCs also face both types of progressive shocks: Senegal is highly vulnerable to progressive shocks because of a high level of vulnerability to an increase of aridity in the East of the country, but also because of the sea level rise in the Senegal river delta (a similar vulnerability is found in Gambia).

As for the "risk of intensification of recurrent shock", this component, on average high for LDCs, also shows a significant variation within the category. The LDCs most vulnerable to an intensification of rainfall and/or temperature recurrent shocks are Burundi, Madagascar, Sierra Leone, Timor Leste and Zambia.These high levels are either due to a very high level of the indices of intensification of both rainfall and temperature shocks (Sierra Leone, Madagascar), or mainly due to the intensification of temperature shocks (Burundi, Timor Leste), or mainly due to the intensification of rainfall shocks (Guinea-Bissau, Myanmar, Zambia). Of course, those countries among the most vulnerable to the intensification of recurrent shocks are to a large extent vulnerable to both types of shocks. Some few other LDCs countries appear to be essentially vulnerable to one kind of shock (Comoros to temperature, Zimbabwe, Malawi and Gambia to rainfall).

Thus, although many LDCs seem to be highly vulnerable to climate change for physical reasons, the precise reason or channel of this (physical) vulnerability may significantly differ from one country to another. These various profiles of vulnerability, to climate change summarized in the Table 2, may help in the design of appropriate adaptation policies.

TAB. 1-PVCCI quadratic, by group of countries (1/3)[3]

group of countries	PVCCI				PROGRESSIVE SHOCKS				INCREASING RECURRENT SHOCKS			
	nb of countries	Mean	Median	Standard Dev.	nb	Mean	Median	Standard Dev	nb	Mean	Median	Standard Dev
All Developing countries (DCs)	118	42,23	41,62	7,95	118	32,67	28,87	15,28	144	47,41	46,10	7,62
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	44,50	44,67	6,74	44	33,63	31,13	13,02	48	51,69	51,01	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
South-Asian Developing countries	8	44,24	43,14	10,33	8	35,43	29,99	22,31	8	48,89	49,76	4,72
South-Asian LDCs	5	45,29	40,42	12,78	5	35,32	16,48	28,34	5	49,54	49,84	49,84
South-Asian Low and LMI countries	8	44,24	43,14	10,33	8	35,43	29,99	22,31	8	48,89	49,76	4,72
Latin Am.and Caribbean Developing countries	25	38,16	36,78	5,62	25	26,19	25,15	7,68	27	46,33	44,98	7,15
Haïti	1	33,48	33,48		1	23,72	23,72	-	1	40,98	40,98	-
Latin Am. and Caribbean Low and LMI countries	9	39,53	36,58	7,55	9	36,37	27,22	7,14	10	48,47	44,58	9,72
East Asia and Pacific Developing countries	23	41,24	36,87	10,56	23	29,14	19,56	20,04	24	48,67	47,96	7,45
East Asia and Pacific LDCs	8	44,53	38,61	12,92	8	33,68	19,57	25,67	9	50,50	49,59	9,76
East Asia and Pacific Low and LMI countries	19	42,90	38,34	10,83	19	31,94	20,08	21,01	20	49,53	49,04	7,68
Europe and Central Asia Developing countries	9	43,88	45,45	8,00	9	46,21	49,25	14,58	23	40,13	40,17	4,54
Europe and Central Asia LDCs	-	-	-	-	-	-	-	-	-	-	-	-
Europe and Central Asia Low and LMI countries	5	47,96	46,72	3,14	5	52,23	52,74	6,51	8	41,65	41,17	4,28
Middle East and North African Developing countries	9	41,51	42,88	5,46	9	39,04	37,58	12,00	13	43,64	42,66	5,02
Middle East and North African LDCs	2	43,43	43,43	0,78	2	37,94	37,94	8,95	2	47,50	47,50	8,59
Middle East and North African Low and LMI countries	6	42,85	43,43	4,29	6	40,49	40,93	12,79	9	43,74	42,66	5,11

[3] Some developing countries may be missing due to the lack of data.

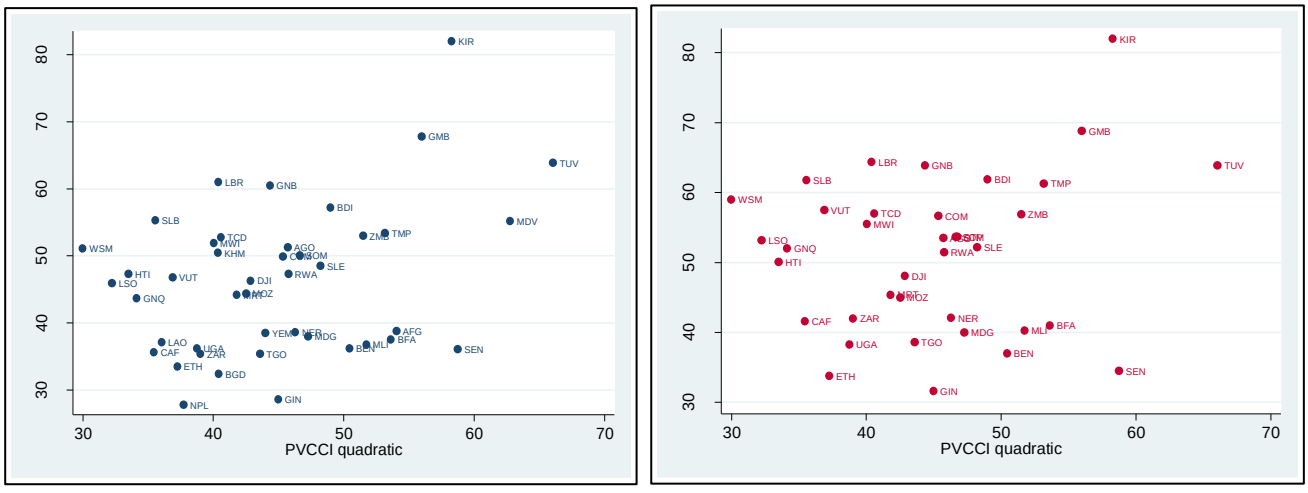
TAB. 2-Various sources of vulnerability to climate change in LDCs

Name of category	PROGRESSIVE SHOCKS		INCREASE IN RECURRENT SHOCKS		Example of countries concerned
	Sea level rise	Increasing aridity	Rainfall shocks	Temperature shocks	
Global High Vulnerability	+ + +		+ + +		Senegal, Gambia
Vulnerability to progressive shocks	+ + +				Benin,
Vulnerability to recurrent shocks			+ + +		Burundi, Sierra Leone, Zambia, Madagascar
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,
Vulnerability to increasing temperature shocks				+ + +	Timor-Leste, Comoros, Rwanda Timor Leste

2.4. PVCCI and EVI: are the two vulnerabilities correlated?

The UN Economic Vulnerability Index (EVI) has been proposed for being used as one of the criteria of the allocation of development assistance between countries (Guillaumont 2008, Guillaumont *et al.* 2010), and development partners have been recently invited to use it for that purpose in a UN General Assembly resolution (A/C.2/67/L.51, December 2012). By the same way, the PVCCI could be used as one of the main criteria for the allocation of the international resources available for the adaptation to climate change. Reflecting the likely needs for adaptation, it would be a relevant criterion precisely because it does not depend on present policy, (Guillaumont 2013). The two indices EVI and PVCCI can have a complementary role in the allocation of international resources, as far as these resources are provided from separate sources. The significant differences in ranking between PVCCI and EVI supports the idea of two specific assessments of "needs".

FIG. 3-PVCCI and EVI for LDCs



We compare PVCCI and EVI in 2012 (see Figure 3 and Table A4 in Appendices), calculated with the current and the 2009's formula. As the current formula includes a component "Share of population in low elevated coastal zones" the EVI 2012 is more correlated to quadratic PVCCI (0.34) than the EVI in 2012 based on the 2009 composition (0.16).

The first part of this study, that relies on an Index of Physical Vulnerability to Climate Change (PVCCI) giving an objective and quantitative assessment of the vulnerabilities of the LDCs' category, has shown a greater vulnerability of LDC compared to other developing countries and an important heterogeneity within the category. These results challenge the choice of appropriate adaptation policies of the LDCs.

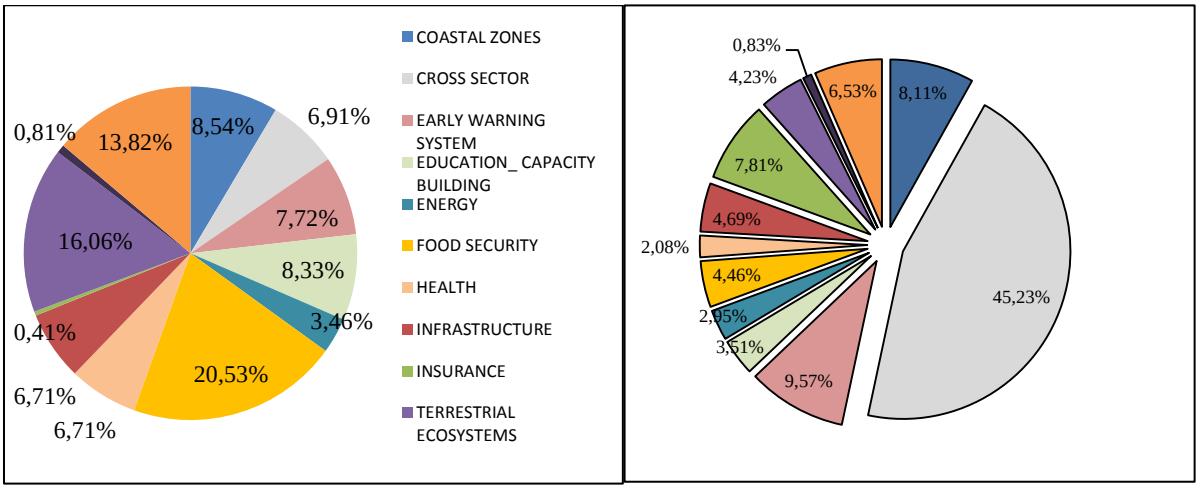
3. The international support to adaptation since IPoA

Having in mind the high level and various sources of vulnerability to climate change evidenced by the LDCs we now examine what has been the response of the international community in particular for supplying LDCs with adequate adaptation resources. It should be recognized that the change observed since the adoption of the IPoA is rather limited. We limit our remarks related to adaptation to one of the main external supports given to them for this purpose that is supplied by the LDC Fund in relation to the implementation of National Adaptation Plan of Actions (NAPAs). Indeed many other sources of international finance can contribute to support the adaptation of the LDCs to climate change (multilateral development bank, UNDP, bilateral donors…). But the IPoA underlines two actions we focus on, because they are additional. The IPoA strongly advices least developed countries, to *"mainstream and implement National Adaptation programmes of Action (NAPAs)…"* (Action 1a.), and for the development partners it recommends, *"in line with international conventions and agreements, (to) provide adequate financial and technical assistance and support, as appropriate to least developed countries to access appropriate, affordable and sustainable technologies needed for the implementation of NAPAs…"* and *"replenish and expedite, as appropriate, the disbursement of funds for adaptation to least developed countries under UNFCCC, including the Least Developed Countries Fund…"*

3.1. "To mainstream and implement NAPAs"

The NAPAs aims at participating in the development of the country, by an appropriate way to the local context. Each project presented in the NAPAs must also demonstrate a positive impact on mitigation or attenuation to climate change. Since 2003, countries prepare their NAPAs. In January 2013, the UNFCCC Secretariat counts 47 NAPAs submitted to the Secretariat. The latest NAPA received is Angola in December 2011. Cape Verde and Maldives, now no longer LDCs, have NAPAs. Bangladesh is the LDC the most advanced in the process, having been the first country to post a NAPAs in December 2005. This country has now fifteen projects in this framework, ordered by priority. UNFCCC distinguishes eleven sectors and one "cross-sectors" category, making clear that adaptation policies are related to all sectors in economy and often difficult to disentangle from general development purposes.

FIG. 4-Development Sector Prioritized by project and costs in NAPAs (%)



Based on data collected from the UNFCCC, the Figure 4 shows that the number of projects is quite balanced divided according to the type of sector. The "terrestrial ecosystems" and "food security" appear to be the two sectors grouping the largest number of projects in LDCs. "Cross sectors" projects are those that concentrate the highest costs. From a sectorial perspective, the most costly projects are on average in the sector of "early warning systems" and the "coastal areas".

As NAPAs provide a prioritization of project, it is interesting to note that these sectors accounting for the largest share of the costs of NAPAs are also areas of highest priority in each country projects, as evidenced by their own declarations (see Table 3).

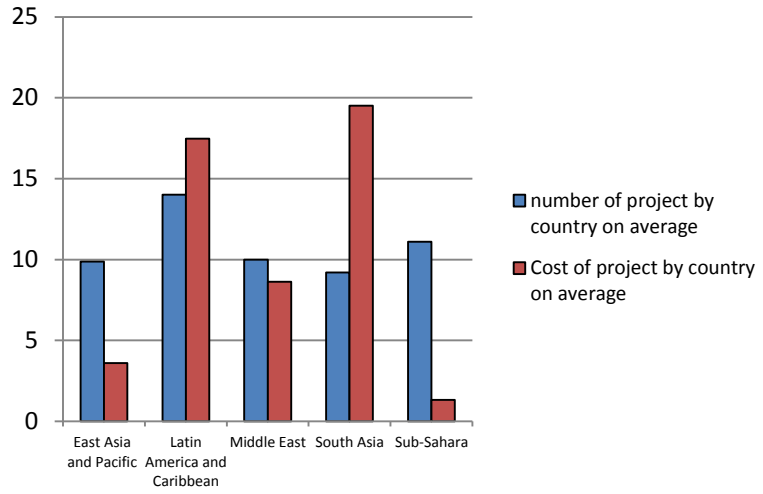
TAB. 3-Mean Rank of priority of project, by sector

	Priority order (on average)
EARLY WARNING SYSTEM	4
CROSS SECTOR	5
WATER RESOURCES	6
TERRESTRIAL ECOSYSTEMS	6
COASTAL ZONES	6
FOOD SECURITY	7
TOURISM	7
INSURANCE	8
INFRASTRUCTURE	8
EDUCATION	8
HEALTH	9
ENERGY	9

Source UNFCCC web site, authors calculations (January 2012 database)

As for the repartition of project costs by country groups, we can note that the countries of South Asia have on average a higher cost by project. As for the number of projects per country is the largest in Haïti. Haiti (i.e. Latin America and Caribbean) left aside, the Figure 5 especially shows emphasizes the large number of projects and low-cost countries in Sub-Saharan Africa and the Pacific. These countries offer indeed a very large number of projects in all sectors. The number of projects is accompanied by a low-cost way for each of them.

FIG. 5-Number and costs of project by country



Source UNFCCC web site, authors 'calculations (January 2012 database)

Finally, there does not seem to be any correlation between each country NAPAs indicators such as the number of projects or the cost of NAPAs in each country and their vulnerability to climate change as measured by the PCCVI. This result is not surprising, since these indicators are supposed to correspond to the economic structure of each country, rather than to its level of vulnerability..

At the end of 2011 almost all LDCs had filled their NAPAs, and started the phase of implementation. The drafting of these plans shows the sensitivity of these countries to climate change. The plans reflect the multidimensional nature of the phenomenon, since most of the projects proposed in the NAPAs are multi-sectoral (UNFCCC website) The NAPAs also provide a rough assessment of the estimated costs of the adaptation of climate change. To carry out these projects, a financial support of the community is necessary. The LDC Fund is especially devoted to finance adaptation of LDCs to climate change.

3.2. "To replenish and expedite the disbursement […] of the LDC Fund."

In the Article 4.9, the United Nations Framework Convention on Climate Change (UNFCCC) recognizes the special situation of LDCs. For this purpose the LDCs Fund was established in 2001 (during the COP 7). The Fund addresses the special concern of the LDCs which are recognized to be especially vulnerable to the adverse impact of climate change. The major action for LDC Fund is to support LDCs in the preparation of National Adaptation Program of Actions.

It is striking that the IPoA considers the climate change in the LDCs in the general section F on multiple crises and other emerging challenges. In this context adaptation is key. Indeed LDCs are also concerned by mitigation issues, as it also appears in the IPoA and the list of actions to be taken by LDC, and their development partners as well. But the policy focus is mainly on the way by which LDCs can face climate change, the path of which is determined by other countries than themselves.

With this respect some indicators seem to be missing in the IPoA to follow the extent to which the LDCs are on the way to address the specific adaptation issues they are facing.

For that reason, as very partial substitute of such indicators we wonder whether the adaptation funds disbursed in direction of LDCs seem to respond to their physical vulnerability to climate change.

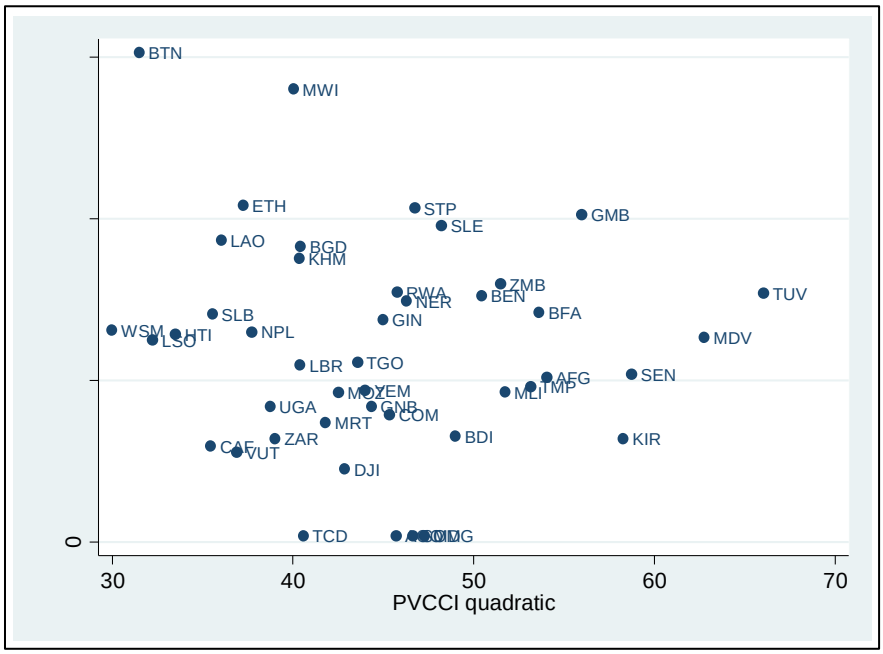
3.3. Is there a link between LDC Fund disbursements by country and the physical vulnerability to climate change?

In 2012 (June), 537 millions of dollars had been pledged to the LDCF. Germany, United Kingdom, United States Sweden and Denmark are the five main countries contributors. Germany contribution is twice more important than the second donor.

Official bilateral development assistance (ODA) disbursements, to LDCs from all donors reported to the Development Assistance Committee of the Organisation for Economic Cooperation and Development (OECD/DAC), reached $26 billion in 2012. The same year the amount of grants from the LDC Fund is $86 million. From the beginning the LDCF supported 74 projects in 44 countries, totaling $334.6 million and leveraging $1.59 billion in co-financing. The most important aim of the LDCF is to finance the preparation and implementation of NAPA. As of June 2012, $346 million have been approved for projects and enabling activities. Since its inception, the LDCF has funded the preparation of 48 NAPAs, of which 47 have been completed, while the remaining one is in the final stage of preparation. Moreover, 46 countries have officially submitted NAPA implementation project. NAPAs preparation is for the LDCs one of the main objectives of IPoA related to Climate Change.

At first glance, there is no simple correlation between the level of the PVCCI and the cumulated amount of LDCF grants, as shown on the Figure 6. But of course the allocation of these grants is likely to depend on other usual factors of aid allocation, primarily the level of income per capita and the population size.

FIG. 6-LDC Fund grants (all projects) and PVCCI



Source: authors' calculation

For exploratory purposes we perform estimates of the allocation of LDCF grants. The results of analysis below must be interpreted with caution, due to the small number of countries and the lack of temporal data. But the analysis, even limited, show some tracks of research to study the issue of the allocation of adaptation assistance.

We regress by OLS, the amounts of grants by country. The model estimated is, for each *i*, LDC:

$$Log\,(G_i) = \alpha + \beta_1\,PVCCI_i + \beta_2\,Log\,(GNI_i) + \beta_3\,Log\,(GNI_i)^2 + \beta 4\,Log\,(Pop_i) + \varepsilon_i$$

with

G: grants amounts of LDC Fund in US constant dollars

PVCCI: index of Physical Vulnerability to Climate Change, as described above

GNI: gross national income

Pop: population

PPG: Project Preparation Grants by the LDCF (in US dollar)

All data are in 2012, and come from Word Development Index Data Base. The amount of grants data come from GEF data base.[4]

[4] Estimations are corrected for heteroskedasticity (White correction). We test robustness of the estimation by replacing data of Gross National Income by data of Gross Domestic Product (in constant US Dollar 2000). We also controlled for EVI in 2012 calculated with the old and last formula, but the coefficient was not significant. We finally and not surprisingly found that the number of projects and the project preparation grants, when introduced in the regressions, are positively correlated to the amount of grants, without clearly modifying the result for the impact of PCCVI.

The Table 4 below presents some results of the estimations, still very tentative. We obtain a positive but not significant impact of the vulnerability index on the grants, the more significant (the less not significant) being when grants are considered with their co-financing. (Column 1) the coefficient is no significant. Finally the coefficient is close to the significativity but still non-significant for completed projects (Column 3).

These results suggest that the allocation of adaptation grants does not clearly respond to the physical vulnerability of the countries. With more data, this relation might be more thoroughly studied.

TAB. 4-LDC Fund Grants and PVCCI

VARIABLES	(1) LDCF Grants and Cofinancing projects	(2) LDCF Grants *All projects*	(3) LDCF Grants *Completed Projects*
PVCCI quadratic	0.0242	0.00823	-7.37e-06
	(0.0146)	(0.00859)	(0.000293)
Log (GNI)	1.914	0.329	-0.0405**
	(1.793)	(1.122)	(0.0184)
Log (GNI)2	-0.140	-0.0118	0.00281**
	(0.134)	(0.0843)	(0.00130)
Log (Pop)	0.134	0.117**	-0.000525
	(0.0821)	(0.0492)	(0.00102)
Observations	35	35	35
R-squared	0.392	0.325	0.119

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; $^{+}$p<0.15

When we introduce each sub-components of the PVCCI (Table 5), only the component "Sea level Rise" is significant and positive for the "grants of LDCF for all projects" and for "LDCF Grants and Cofinancing projects" only.

While by definition the adaptation resources mobilized by the LDC fund are directed to these countries that are among the most vulnerable ones, these results indicate that within this group there no evidence of an allocation guided by an assessment of the relative vulnerability of countries to climate change. Among the components of the PVCCI, only the sea level rise seems to have an impact.

TAB. 5-LDC Fund Grants and PVCCI by components

VARIABLES	(1) LDCF Grants and Cofinancing projects	(2) LDCF Grants All projects	(3) LDCF Grants Completed Projects
SLR	**0.0188***	**0.0125****	-6.86e-05
	(0.00956)	**(0.00562)**	(0.000103)
OA	-0.000732	-0.000444	3.96e-05
	(0.00589)	(0.00344)	(0.000124)
RS	0.0110	0.00106	0.000125
	(0.0120)	(0.00672)	(0.000149)
TS	0.00936	-0.00134	-0.000148
	(0.00904)	(0.00525)	(0.000199)
Log (GNI)	4.616*	2.188	-0.0578*
	(2.447)	(1.398)	(0.0338)
Log (GNI)2	-0.357*	-0.163	0.00413^{+}
	(0.193)	(0.111)	(0.00259)
Log (Pop)	0.120	0.109*	-0.00122
	(0.102)	(0.0586)	(0.00138)
Observations	35	35	35
R-squared	0.469	0.451	0.380

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; $^{+}$p<0.15

Let us now divide the grants received by each country by sector (Table 6), the estimations are rather weak, since data are rare. However, these preliminary results show a possible positive relation between the kind of vulnerability faced by each country and the kind of project funded. The choice of project seems in line with the vulnerability of the country.

TAB. 6-LDC Fund Grants by sector and PVCCI by components

VARIABLES	(1) Food security and Agriculture	(2) Water resources	(3) Early Warning Systems	(4) Coastal Management	(5) Disaster Risks Management
SLR	-0.00366	0.0112	0.0154	0.00414	**-0.0201*****
	(0.00993)	(0.00786)	(0.0151)	(0.00937)	**(0.00341)**
OA	0.00648	**0.0276****	0.00679	**0.0424****	**-0.0257***
	(0.00615)	**(0.00963)**	(0.0134)	**(0.0147)**	**(0.0126)**
RS	**0.0324***	0.00593	-0.00442	-0.000502	**0.0836****
	(0.0171)	(0.0181)	(0.0336)	(0.0410)	**(0.0214)**
TS	**-0.0364***	0.00752	0.0109	0.0151	**0.0415*****
	(0.0187)	(0.0182)	(0.0320)	(0.0192)	**(0.00849)**
Log (GNI)	-2.028	8.886	4.264	-9.635**	-0.930
	(3.095)	(6.250)	(5.218)	(3.557)	(2.857)
Log (GNI)2	0.140	-0.711	-0.337	0.731**	-0.0107
	(0.252)	(0.459)	(0.407)	(0.267)	(0.188)
Log (Pop)	-0.100	-0.199	0.0493	0.484	-0.679**
	(0.169)	(0.248)	(0.263)	(0.270)	(0.184)
Observations	25	14	17	14	13
R-squared	0.450	0.637	0.161	0.822	0.908

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; + p<0.15

The second part of this study compared adaptation policies adopted by the LDCs though their NAPAs, the allocation of adaptation funds and the countries' vulnerability to climate change. Two major points can be noted in the context of IPoA Monitor. LDCs have almost all set up the NAPAs since May 2011 (except Equatorial Guinea, Myanmar and Uganda) and the LDC Fund increased significantly grants towards the countries. But this section also shows a weak correlation between adaptation grants and the physical vulnerability to climate change, as measured by our index, although the kind of projects financed seem to some extent to correspond to the kinds of vulnerability faced by each country. These results suggest that more thinking is needed about the criteria of adaptation assistance to LDCs, and other developing countries as well.

4. Conclusion

The IPoA considers the challenge of climate change in the LDCs. It noticeably recommends the implementation of National Adaptation Plans by the LDCs and the disbursements of funds for adaptation by the development partners. To be well grounded the monitoring of such actions involves to refer to an assessment of the level and nature of the countries vulnerability to climate change. For that we use a “physical vulnerability to climate change index” showing the level and the various sources of vulnerability of the countries. Because through its components it evidences the kind of vulnerability to climate change each LDC has to face, it can be used for the orientation of adaptation policies. Because it relies only on physical and policy neutral components, it can be used as a major criterion of the allocation of international resources available for adaptation.

The paper has shown the relatively high vulnerability of LDCs to climate change and its main sources. It has also examined the advancement of the NAPAs. But the adequacy of the response of the international community to this vulnerability in order to make the adaptation to climate change easier has appeared more uncertain, as revealed by the allocation of the LDC Fund for adaptation, indeed only a part of these resources. One should recognize the difficulty to assess this adequacy, due both to a lack of data and to the absence of a clear border between the supply of resources specifically devoted to adaptation and the more traditional development assistance. This may also explain why there is little academic and research literature on the subject of NAPAs and adaptation assistance. More research on this topic would help the orientation of these plans and the evaluation of their implementation.

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Annex

TAB. A1-Actions relative to Climate Change in the IPoA

General Goal	**Strengthen least developed countries' ability to withstand and overcome the adverse effects of climate change, enhance sustainable growth and protect biodiversity (*paragraph 94*)**
Hypothesis	Climate change disproportionately affects the socio-economic development of least developed countries, considering that they have contributed least to the problem *[…] (paragraph 97)*
Action by development partners	
(a) […] provide adequate financial and technical assistance and support, as appropriate, to least developed countries to access appropriate, affordable and sustainable technologies needed for the implementation of NAPAs and NAMAs and the transfer of such technologies under mutually agreed terms (b) Facilitate least developed countries' access to required resources from different environment and climate funds, including the Global Environment Facility (GEF) (c) Provide financial and technical assistance and facilitate technology transfer under mutually agreed terms to least developed countries' efforts to develop and implement national strategies for sustainable use, preservation and protection of the national environmental resources and the sustainable management of marine biodiversity and ecosystems in line with their broader sustainable development strategies (d) Replenish and expedite […], the disbursement of funds for adaptation to least developed countries under UNFCCC, including the Least Developed Countries Fund, the Adaptation Fund, and other funds disbursed through other global and bilateral programmes; (e) Accelerate the legal and institutional arrangements for the establishment and full operationalization of the Green Climate Fund […] (f) Implement measures to promote and facilitate clean development mechanism projects in least developed countries […] (g) Help least developed countries address the challenges of livelihood and food security and health of the people affected by the adverse impact of climate change […] at national, regional and international levels (h) Support enhancing the capacity of meteorological and hydrological services of least developed countries (i) Assist least developed countries to enhance capacities in clean energy production, trade and distribution, including renewable energy development.	
Action by least developed countries	
(a) Mainstream and implement national adaptation programmes of action (NAPAs), medium and long-term national adaptation plans and nationally appropriate mitigation actions (NAMAs), and integrate these into national development plans; (b) Build and strengthen national capacity to access and efficiently absorb relevant funding mechanisms (c) Strive to ensure that development plans and programmes integrate adaptation considerations […] (d) Develop and implement national strategies for sustainable use, preservation and protection of the national environmental resources (e) Develop or update and implement national action plans stemming from biodiversity-related conventions (f) Mainstream policies dealing with climate change, biodiversity conservation and sustainable use of the ecosystem […] (g) Take measures to mainstream sustainable management of marine biodiversity and ecosystems.	

TAB. A2-PVCCI quadratic, by group of countries (1/2 *Following the Table 1*)

group of countries	PROGRESSIVE SHOCKS				Sea level rise				Increasing over aridity			
	number of countries	Mean	Median	Standard Deviation	number of countries	Mean	Median	Standard Deviation	number of countries	Mean	Median	Standard Deviation
All Developing countries (DCs)	118	32,67	28,87	15,28	124	6,07	0,99	18,71	136	43,44	37,44	18,77
Least Developed Countries (LDCs)	46	33,20	26,32	16,84	48	7,51	0,67	24,19	47	42,50	36,41	18,48
All Developing countries non LDCs	72	32,51	29,49	14,33	76	5,17	1,29	14,32	90	43,93	39,06	19,00
Low and Lower Middle Income countries	84	33,98	30,43	15,82	88	6,70	0,84	21,22	91	45,64	40,70	19,00
Low and LMI countries non LDCs	39	34,49	32,18	14,72	41	5,59	1,00	17,06	45	48,48	45,49	19,28
Small Islands Developing States (SIDS)	29	32	24,93	18,76	29	23	3,80	34,39	31	31	28,14	7,81
SIDS non LDCs	18	28,23	24,41	14,70	18	19,98	5,83	26,36	20	29,32	27,79	7,38
SIDS-LDCs	11	38,55	28,85	23,36	11	29,10	2,84	45,54	11	34,29	33,48	7,87
Landlocked Developing Countries (LLDCs)	27	38,07	42,54	16,34	28	0,12	0,00	0,62	28	54,55	60,33	22,98
LLDCs non LDCs	11	49,54	49,96	9,81	12	0,00	0,00	0,00	12	70,35	72,16	13,27
LLDCs-LDCs	16	30,19	23,92	15,36	16	0,21	0,00	0,82	16	42,69	33,82	21,71
African Developing countries	44	33,63	31,13	13,02	46	1,87	0,28	6,49	46	46,62	41,28	19,10
African LDCs	30	32,71	27,66	12,72	31	1,01	0,36	1,42	31	46,75	40,70	17,91
African Low and LMI countries	37	33,05	29,60	12,22	39	0,94	0,16	1,34	38	47,13	44,02	17,23
South-Asian Developing countries	8	35,43	29,99	22,31	8	13,81	1,26	34,88	8	40,51	30,72	23,57
South-Asian LDCs	5	35,32	16,48	28,34	5	21,21	0,00	44,12	5	34,60	23,31	26,82
South-Asian Low and LMI countries	8	35,43	29,99	22,31	8	13,81	1,26	34,88	8	40,51	30,72	23,57
Latin Am.and Caribbean Developing countries	26	26,19	25,15	7,68	27	4,63	1,78	9,01	27	35,46	34,67	10,13
Haïtis	1	23,72	23,72		1	2,28	2,28	-	1	33,48	33,48	-
Latin Am. and Caribbean Low and LMI countries	9	36,37	27,22	7,14	10	0,00	0,00	0,00	8	54,87	59,84	23,60
East Asia and Pacific Developing countries	23	29,14	19,56	20,04	24	17,38	2,36	33,37	23	30,17	27,06	11,55
East Asia and Pacific LDCs	8	33,68	19,57	25,67	9	23,81	2,36	43,20	8	29,33	27,58	8,21
East Asia and Pacific Low and LMI countries	19	31,94	20,08	21,01	20	20,45	2,36	35,90	19	31,83	28,09	11,94
Europe and Central Asia Developing countries	9	46,21	49,25	14,58	11	0,00	0,00	0,00	21	52,57	44,24	20,29
Europe and Central Asia LDCs	-	-	-	-	-	-	-	-	-	-	-	-
Europe and Central Asia Low and LMI countries	5	52,23	52,74	6,51	5	0,00	0,00	0,00	8	68,30	71,66	13,13
Middle East and North African Developing countries	9	39,04	37,58	12,00	9	2,16	1,46	1,93	13	58,71	62,34	15,47
Middle East and North African LDCs	2	37,94	37,94	8,95	2	3,23	3,23	3,74	2	53,52	53,52	12,47
Middle East and North African Low and LMI countries	6	40,49	40,93	12,79	6	2,41	1,83	2,32	9	61,58	65,51	15,88

TAB. A2-PVCCI quadratic, by group of countries (2/2 *Following the Table 1*)

group of countries	number of countries	INCREASE IN RECURENT SHOCKS			Rainfall shocks			Temperature shocks		
		Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
All Developing countries (DCs)	144	47,41	46,10	7,62	43,29	108,00	55,76	50,22	46,74	10,08
Least Developed Countries (LDCs)	49	51,82	51,71	7,65	47,74	49,06	11,91	54,32	50,18	10,90
All Developing countries non LDCs	95	45,14	44,76	6,60	41,00	40,62	9,28	48,11	45,09	8,97
Low and Lower Middle Income countries	95	49,19	49,21	7,66	45,71	45,60	10,73	51,37	48,11	10,71
Low and LMI countries non LDCs	47	46,35	45,52	6,61	43,45	43,25	8,86	48,26	45,63	9,55
Small Islands Developing States (SIDS)	31	47	45,92	7,17	40,72	41,18	9,75	52,10	48,50	10,97
SIDS non LDCs	20	45,60	45,47	4,88	40,70	41,18	5,90	49,39	47,15	8,94
SIDS-LDCs	11	50,49	49,84	9,59	40,77	39,62	14,81	57,02	52,47	12,95
Landlocked Developing Countries (LLDCs)	29	47,52	48,97	8,26	44,57	43,53	11,37	49,47	46,05	9,61
LLDCs non LDCs	13	44,02	42,99	6,43	40,95	38,06	10,78	46,33	44,39	4,91
LLDCs-LDCs	16	50,35	49,66	8,66	47,51	49,57	11,31	52,02	46,15	11,73
African Developing countries	48	51,69	51,01	7,17	47,75	49,03	11,44	54,12	50,97	10,50
African LDCs	32	53,15	53,11	7,24	49,36	50,43	10,87	55,52	53,37	11,04
African Low and LMI countries	40	51,99	51,38	7,18	48,26	49,57	11,56	54,25	51,79	10,40
South-Asian Developing countries	8	48,89	49,76	4,72	50,26	50,56	9,58	46,97	46,61	2,79
South-Asian LDCs	5	49,54	49,84	49,84	51,80	54,47	10,39	46,56	45,10	3,58
South-Asian Low and LMI countries	8	48,89	49,76	4,72	50,26	50,56	9,58	46,97	46,61	2,79
Latin Am.and Caribbean Developing countries	27	46,33	44,98	7,15	39,97	38,81	6,56	51,15	46,26	11,86
Haïtis	1	40,98	40,98		34,93	34,93		46,26	46,26	
Latin Am. and Caribbean Low and LMI countries	10	48,47	44,58	9,72	41,53	39,22	6,36	53,82	47,60	15,30
East Asia and Pacific Developing countries	24	48,67	47,96	7,45	45,63	44,31	11,05	50,26	46,80	11,12
East Asia and Pacific LDCs	9	50,50	49,59	9,76	43,69	44,31	15,62	54,75	50,18	12,86
East Asia and Pacific Low and LMI countries	20	49,53	49,04	7,68	46,87	47,18	11,66	50,58	46,80	11,87
Europe and Central Asia Developing countries	23	40,13	40,17	4,54	34,67	34,92	6,87	44,64	43,98	4,65
Europe and Central Asia LDCs	-	-	-	-	-	-	-	-	-	-
Europe and Central Asia Low and LMI countries	8	41,65	41,17	4,28	37,48	36,91	4,45	45,28	43,98	5,84
Middle East and North African Developing countries	13	43,64	42,66	5,02	39,89	38,14	8,87	46,42	44,81	6,30
Middle East and North African LDCs	2	47,50	47,50	8,59	36,22	36,22	5,08	56,57	56,57	11,17
Middle East and North African Low and LMI countries	9	43,74	42,66	5,11	39,68	38,14	6,93	46,96	43,57	7,49

TAB. A3-PVCCI quadratic by countries

	Sea Level Rise		Increasing Over Aridity		Increase in Rainfall Shocks		Increase in Temperature Shocks		Progressive Shocks		Recurrent Shocks		PVCCI quadratic	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Afghanistan	0,00	1	82,14	47	54,47	35	44,39	8	58,08	43	49,69	18	54,05	41
Angola	0,08	18	36,41	24	63,36	45	54,91	30	25,74	21	59,29	42	45,70	27
Bangladesh	6,05	45	17,97	3	64,85	46	44,39	8	13,41	3	55,57	36	40,42	17
Benin	2,11	30	68,55	42	52,90	30	51,76	26	48,49	38	52,33	27	50,45	35
Bhutan	0,00	1	21,46	4	37,25	10	46,05	13	15,17	4	41,88	7	31,50	2
Burkina Faso	0,00	1	78,47	44	53,20	33	50,18	24	55,49	40	51,71	25	53,63	40
Burundi	0,00	1	33,00	18	49,06	25	78,15	48	23,34	16	65,25	47	49,00	34
Cambodia	2,30	32	26,86	9	57,15	39	50,18	24	19,06	9	53,78	29	40,35	15
Central African Rep.	0,00	1	29,70	15	46,99	21	44,01	5	21,00	13	45,53	10	35,45	6
Chad	0,00	1	62,13	37	24,24	2	46,25	15	43,93	34	36,92	1	40,58	18
Comoros	2,84	37	40,70	28	25,00	3	77,04	47	28,85	25	57,27	38	45,34	26
Congo, The Dem. Rep.	0,01	16	25,96	7	45,22	19	58,03	36	18,35	7	52,02	26	39,01	13
Djibouti	5,87	44	62,34	38	32,63	7	48,67	21	44,27	35	41,43	6	42,88	21
Equatorial Guinea	0,38	21	25,51	6	39,47	12	49,51	22	18,04	6	44,77	9	34,13	5
Eritrea			62,39	39	57,84	40	42,59	2			50,79	23		
Ethiopia	3,29	41	51,28	34	31,03	6	44,12	7	36,33	31	38,14	4	37,25	10
Gambia	5,31	43	79,80	45	54,86	36	55,96	31	56,55	41	55,41	35	55,99	42
Guinea	0,82	27	36,57	25	53,60	34	62,30	38	25,86	22	58,12	41	44,98	25
Guinea-Bissau	3,08	40	33,90	20	65,07	47	49,78	23	24,07	18	57,93	40	44,36	24
Haiti	2,28	31	33,48	19	34,93	8	46,26	16	23,73	17	40,99	5	33,49	4
Kiribati	100	46	28,09	13	27,12	4	45,44	11	73,45	44	37,42	2	58,29	43
Lao People's Dem. Rep.	0,00	1	16,60	1	52,90	30	46,05	13	11,74	1	49,59	16	36,04	8
Lesotho	0,00	1	17,94	2	43,53	16	44,03	6	12,69	2	43,78	8	32,23	3
Liberia	0,42	22	26,82	8	49,00	24	58,38	37	18,96	8	53,89	30	40,40	16
Madagascar	0,78	26	36,99	26	59,15	42	63,82	39	26,16	23	61,53	45	47,28	32
Malawi	0,00	1	34,64	21	58,17	41	42,74	3	24,49	19	51,04	24	40,03	14
Maldives	100	46	28,14	14	46,65	20	52,84	29	73,46	45	49,84	19	62,77	45
Mali	0,00	1	69,63	43	56,35	38	51,83	27	49,24	39	54,14	32	51,74	38
Mauritania	2,77	35	51,92	35	44,41	18	48,11	19	36,76	32	46,30	11	41,80	19
Mozambique	0,54	23	46,19	32	59,23	43	39,85	1	32,66	29	50,48	20	42,51	20
Myanmar	2,88	39			69,62	49	42,74	3			57,76	39		
Nepal	0,00	1	23,31	5	55,79	37	45,10	10	16,48	5	50,73	22	37,72	11
Niger	0,00	1	61,47	36	50,09	26	47,82	18	43,47	33	48,97	15	46,30	29
Rwanda	0,00	1	31,11	16	38,46	11	76,99	46	22,00	14	60,85	44	45,75	28
Samoa	2,36	33	28,09	12	27,12	4	45,44	11	19,94	12	37,42	2	29,98	1
Sao Tome and Principe	2,78	36	49,77	33	63,23	44	47,50	17	35,25	30	55,92	37	46,74	31
Senegal	3,34	42	80,22	46	48,57	23	70,71	44	56,78	42	60,66	43	58,75	44
Sierra Leone	1,39	28	34,85	22	47,70	22	76,22	45	24,66	20	63,58	46	48,22	33
Solomon Islands	2,84	37	26,89	10	39,62	13	52,47	28	19,12	10	46,49	12	35,55	7
Somalia	0,36	20	65,37	40	35,46	9	56,23	32	46,22	36	47,01	13	46,62	30
Sudan	0,08	19	65,96	41	52,23	29	58,03	35	46,64	37	55,21	33	51,10	36
Tanzania, Un. Rep.	0,07	17			52,90	30	48,11	19			50,56	21		
Timor-Leste	1,56	29	44,91	31	51,41	28	81,53	49	31,77	28	68,15	49	53,17	39
Togo	0,75	25	41,86	29	50,77	27	57,14	33	29,60	26	54,05	31	43,57	22
Tuvalu	100	46	36,16	23	44,31	17	64,64	42	75,19	46	55,41	34	66,05	46
Uganda	0,00	1	32,80	17	39,62	13	57,96	34	23,19	15	49,64	17	38,75	12
Vanuatu	2,36	33	27,06	11	23,99	1	64,23	40	19,21	11	48,48	14	36,87	9
Yemen	0,58	24	44,70	30	39,81	15	64,46	41	31,61	27	53,57	28	43,99	23
Zambia	0,00	1	37,44	27	68,97	48	66,64	43	26,47	24	67,82	48	51,48	37

TAB. A4- Ranking comparison between EVI and PVCCI

	EVI 2012	Rank (1)	EVI 2012 (Basis 2009)*	Rank (2)	PVCCI quadratic	Rank (3)	**Rank variation (3-1)**	**Rank variation (3-2)**
Afghanistan	38,8	17	41,0	14	54,05	41	**-24**	**27**
Angola	51,3	33	53,5	27	45,7	27	**6**	**0**
Bangladesh	32,4	3	24,3	1	40,42	17	**-14**	**16**
Benin	36,2	9	37,0	7	50,45	35	**-26**	**28**
Bhutan	44,2	19	53,6	28	31,5	2	**17**	**-26**
Burkina Faso	37,5	13	41,0	13	53,63	40	**-27**	**27**
Burundi	57,2	40	61,9	40	49	34	**6**	**-6**
Cambodia	50,5	31	49,9	21	40,35	15	**16**	**-6**
Central African Rep.	35,6	7	41,6	15	35,45	6	**1**	**-9**
Chad	52,8	35	57,0	35	40,58	18	**17**	**-17**
Comoros	49,9	29	56,7	33	45,34	26	**3**	**-7**
Congo, The Dem. Rep.	35,4	5	36,1	6	39,01	13	**-8**	**7**
Djibouti	46,3	24	48,1	20	42,88	21	**3**	**1**
Equatorial Guinea	43,7	18	52,0	24	34,13	5	**13**	**-19**
Ethiopia	33,5	4	33,8	4	37,25	10	**-6**	**6**
Gambia	67,8	44	68,8	44	55,99	42	**2**	**-2**
Guinea	28,6	2	31,6	3	44,98	25	**-23**	**22**
Guinea-Bissau	60,5	41	63,9	41	44,36	24	**17**	**-17**
Haiti	47,3	26	50,1	22	33,49	4	**22**	**-18**
Kiribati	82	45	82,0	45	58,29	43	**2**	**-2**
Lao Peo.Dem. Rep.	37,1	12	42,4	17	36,04	8	**4**	**-9**
Lesotho	45,9	23	53,2	26	32,23	3	**20**	**-23**
Liberia	61	42	64,4	43	40,4	16	**26**	**-27**
Madagascar	38	14	40,0	10	47,28	32	**-18**	**22**
Malawi	51,9	34	55,5	32	40,03	14	**20**	**-18**
Maldives	55,2	38	53,7	30	62,77	45	**-7**	**15**
Mali	36,8	11	40,3	11	51,74	38	**-27**	**27**
Mauritania	44,2	19	45,4	19	41,8	19	**0**	**0**
Mozambique	44,4	21	45,0	18	42,51	20	**1**	**2**
Nepal	27,8	1	30,0	2	37,72	11	**-10**	**9**
Niger	38,6	16	42,1	16	46,3	29	**-13**	**13**
Rwanda	47,3	26	51,5	23	45,75	28	**-2**	**5**
Samoa	51,1	32	59,0	37	29,98	1	**31**	**-36**
Sao Tome and P.			53,7	29	46,74	31	**-31**	**2**
Senegal	36,1	8	34,5	5	58,75	44	**-36**	**39**
Sierra Leone	48,5	28	52,2	25	48,22	33	**-5**	**8**
Solomon Islands	55,3	39	61,8	39	35,55	7	**32**	**-32**
Somalia	50,1	30	53,7	31	46,62	30	**0**	**-1**
Sudan	44,4	21			51,1	36	**-15**	**36**
Timor-Leste	53,4	37	61,3	38	53,17	39	**-2**	**1**
Togo	35,4	5	38,6	9	43,57	22	**-17**	**13**
Tuvalu	63,9	43	63,9	42	66,05	46	**-3**	**4**
Uganda	36,2	9	38,3	8	38,75	12	**-3**	**4**
Vanuatu	46,8	25	57,5	36	36,87	9	**16**	**-27**
Yemen	38,5	15	40,7	12	43,99	23	**-8**	**11**
Zambia	53	36	56,9	34	51,48	37	**-1**	**3**

a: See Cariolle, Goujon, and Guillaumont, (2014)

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