Chapter 8

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

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Summary

The climate change issue is briefly considered in Section IV. Priority areas for action, F. Multiple crises and other emerging challenges of the Istanbul Programme of Action (IPoA). In section F, climate change is examined along with environmental sustainability, economic shocks and disaster risk reduction. The monitoring of the recommendations in this section on climate change is fairly complex, since the actions do not refer to monitoring indicators, either measurable or observable. In order to monitor these actions we propose, first, to identify, through an indicator of physical vulnerability to climate change, the level and type of vulnerability to climate change of the least developed countries (LDCs). Second, we evaluate two types of actions recommended by the IPoA: establishment of national adaptation programmes of action (NAPAs) and the LDC Fund orientation. The first part of this chapter shows the high level of vulnerability of the LDCs and their heterogeneous profiles of vulnerability to climate change. The second part is an assessment of the actions recommended by the IPoA for adaptation to climate change, considering the needs of the countries as identified by the index.

8.1 Introduction

The international community has recognised that climate change has an unbalanced impact on developing countries and poor populations. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (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 climate change. Moreover, they often display a low adaptation capacity due to institutional weaknesses, particularly in the financial sector. In many developing countries, climate change increases stresses from climate variability (IPCC 2007).

The LDCs are characterised by 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 IPoA (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 IPoA considered climate change and environmental sustainability among the 'priority areas of action' (Chapter 4, section F, under the heading 'Multiple crises and other emerging challenges'), This section of the IPoA contains two other major issues: economic shocks and disaster risk reduction. Moreover, 4 pages out of 74 dedicated to the priority area are related to climate change and environmental sustainability. Thus, the climate change issue is not presented clearly in the declaration, although the recommendations made are highly important for the international community. One of the main goals as stated at the beginning of 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'. Regarding the actions to be taken by the LDCs (seven actions) and the development partners (nine actions), those related to climate change are essentially focused on adaptation (see Annex 8.1). However, monitoring the recommendations about climate change is rather difficult since the actions of the IPoA on this topic do not refer to monitoring indicators, either measurable or observable.

The fact that the countries which are not the most responsible for climate change suffer disproportionately 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 2007). As the characteristics of each country are heterogeneous, the vulnerability to climate change in 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 8.2) 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 to climate change as well as their heterogeneity in this respect, and consequently in the required adaptation policies, constitutes the first step of this chapter. We highlight the highest vulnerability of LDCs to climate change compared with other developing countries and we analyse the heterogeneity of their vulnerability profiles.

If the vulnerability of LDCs to climate change is high, it requires resources for adaptation as 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. Section 8.3 looks at monitoring the main actions taken for helping LDCs to face climate change. As these countries are less responsible for the phenomenon but suffer more as victims, we focus on the adaptation challenge underlined in the IPoA. We examine the international support to the adaptation policies, in particular through the LDC Fund, noticeably in the implementation of NAPAs of the LDCs.

Thus, the first part of the chapter examines 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 examine the extent to which resources and climate policies implemented since 2011 meet the guidelines of the IPoA and whether they are consistent with the assessment of vulnerability made in the previous section.

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

In general, it is recognised that the the LDCs are victims of climate change. However, this view generally does not rely on a quantitative evaluation. Here, we show that these countries are vulnerable to climate change, using a physical vulnerability index that is independent of policies. The idea of an assessment of physical vulnerability is consistent with common vulnerability frameworks, as explained in Guillaumont and Simonet (2011a), and also with the SREX (2012) conceptual framework, but it involves making a systematic distinction between what is and what is not independent of a country's 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), that has already been applied to differentiate 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.

8.2.1 Composition

The expanding literature on the economic consequences of climate change leads us to distinguish between two kinds of physical impacts of climate change and related risks: risks of progressive shocks and risks of increasingly 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.[2] 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 two-fold. 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:

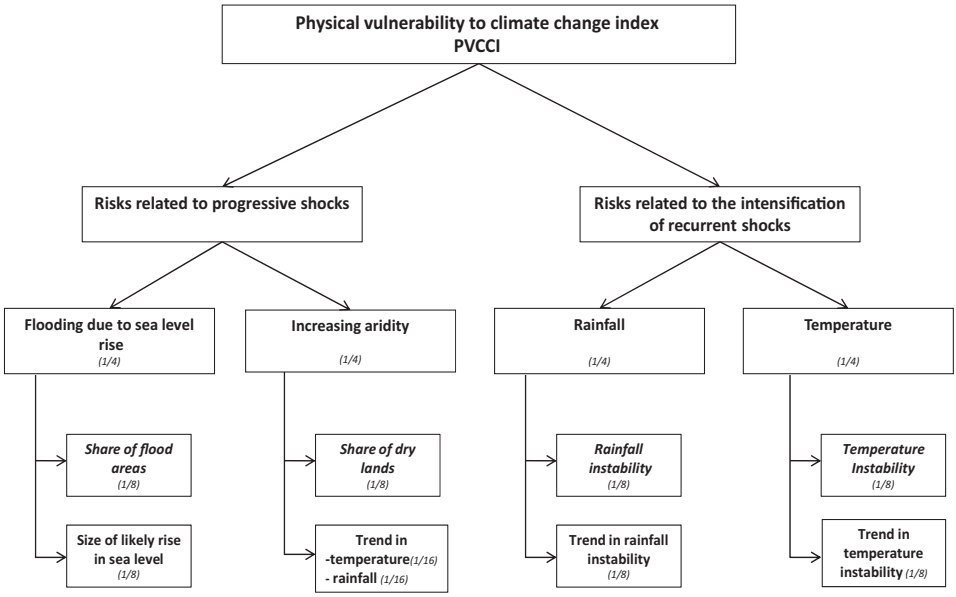
this is abolutely necessary if the index is to be used as a criterion for the allocation of international ressources, as explained below. Second, this physical index does not involve an assessment of the expected impact of climate change on variables such as health and agriculture, which unavoidably 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 flooding, and an increase of aridity, possibly leading to desertification. The vulnerability of a country to sea level rise is shown by the risk of this country being 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 a shock and the size of the shock. The exposure can here be proxied by the actual share of dry land in the country (or the actual average level of rainfall in the country). The higher the share of dry land (or the lower the rainfall level), the higher is the risk of being affected. As for the size of the shocks, it appears to be relevant to retain the trend in the annual average temperature in each country over the last few 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 increasing intensity of recurrent shocks generated by climate change include more frequent or more acute natural shocks in rainfall and temperature (such as droughts, typhoons, floods). 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 past rainfall and temperature instabilities). The shock component here is the risk of an increase in 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 past shocks (or the trends in rainfall and temperature instabilities), supposing that these trends are determined by climate change and are likely to continue in the future. These two components are measured in the same way as for rainfall and temperature. Each of the eight components is normalised 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 of the level of the other components. It is then relevant to use an averaging method that reflects this limited substitutability between components, either by a quadratic average of the components or by a reversed geometric average (as discussed in Guillaumont 2009a,b).

The structure of the index is presented in Figure 8.1, which distinguishes between 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 the sea level rise and the trend in average rainfall and temperature. The

Figure 8.1 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 (roman) respectively

intensification of recurrent shocks corresponds to rainfall shocks and temperature shocks. For each of these four main components, an exposure index (marked on Figure 8.1 in italics) and a shocks index have been computed.

The physical vulnerability to climate change index (PVCCI) thus gathers eight sub-components into four components reflecting two kinds of shocks (progressive ones and increasingly 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 et 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).[3]

The physical vulnerability to climate change index (PVCCI) still meets some limitations and can of course be refined. For instance, it currently 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. Nevertheless, it seems that this is the first index to allow one to compare the vulnerability to climate change for most countries from only physical data, reflecting the most likely major impacts of climate change in developing countries that have been identified.

8.2.2 LDCs are physically more vulnerable to climate change than other developing countries

As is stated in the IPoA, the population of LDCs is highly vulnerable to climate change. Using our PVCCI, we indeed find evidence of 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 fisheries. 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 per cent by 2020 in some countries (IPCC 2007, Chapter 9). The small-scale low-income farmers will probably be the most affected. This effect on agriculture would result both in lower economic growth and in 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 US 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 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 low-income islands, often considered as particularly vulnerable. Small island developing states (SIDS) and most island LDCs are those most exposed to this trend.

Differences by category

The index of vulnerability to climate change presents a higher level for LDCs than for other developing countries. The LDCs are more exposed to climate change impacts and are suffering from severe 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 extreme vulnerability of the category reveals heterogeneous profiles of vulnerability among the group.

In Table 8.1 (find an extension in Annex 8.2a and 8.2b), we compare LDCs to other developing countries (low income and lower middle income) or other geographical groups of developing countries (landlocked countries and small islands) using the

Table 8.1 PVCCI quadratic, by group of countries (1/3)[a]

Group of countries	PVCCI				Progressive shocks				Increasing recurrent shocks			
	Number of countries	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation
All developing countries	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-income countries (LICs) and lower middle-income countries (LMICs)	84	43.62	43.72	7.81	84	33.98	30.43	15.82	95	49.19	49.21	7.66
LICs and LMICs, 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 LICs and LMICs	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 LICs and LMICs	8	44.24	43.14	10.33	8	35.43	29.99	22.31	8	48.89	49.76	4.72
Latin American 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

Table 8.1 PVCCI quadratic, by group of countries (1/3)[a] (continued)

Group of countries	PVCCI				Progressive shocks				Increasing recurrent shocks			
	Number of countries	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation
Haïti	1	33.48	33.48		1	23.72	23.72	–	1	40.98	40.98	–
Latin American and Caribbean LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	6	42.85	43.43	4.29	6	40.49	40.93	12.79	9	43.74	42.66	5.11

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

PVCCI. The LDCs are more vulnerable than other groups of countries on average (44.6 compared with 40.8 for developing countries that are not LDCs). The component 'risk of progressive shocks' presents almost the same value for LDCs than for the other countries (33.2 v. 32.5 in other developing countries). The risk of increasingly recurrent shocks is higher than for other developing countries (54.1 v. 51.8).[4]

Within the LDC category, the SIDS–LDCs countries seem most vulnerable (46.6), with also the highest standard deviation. This sub-category presents an average level of vulnerability higher than the entire 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 landlocked developing country (LLDC)–LDCs category presents a high level of vulnerability, but this vulnerability is no higher than the vulnerability of LLDCs, which is very important (the LLDC–LDCs category is more vulnerable to risk of increasingly recurrent shocks, but non-LDC LLDCs 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 increasingly 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).

8.2.3 Heterogeneity of physical vulnerability among LDCs

Since the index is estimated country by country, it exhibits a large heterogeneity in the levels and types of vulnerability among countries as highlighted by Figure 8.2. It measures a high average vulnerability to climate change for LDCs, but also shows levels to be very uneven across LDCs, and resulting from various components (see Annex 8.3).

The four most vulnerable LDCs with regard to the PVCCI are The Gambia, Kiribati, Senegal and Tuvalu; Maldives, a former LDC, were also in this group. 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 (Tuvalu, Afghanistan, Kiribati, Maldives, Senegal) at the highest level in the world. For

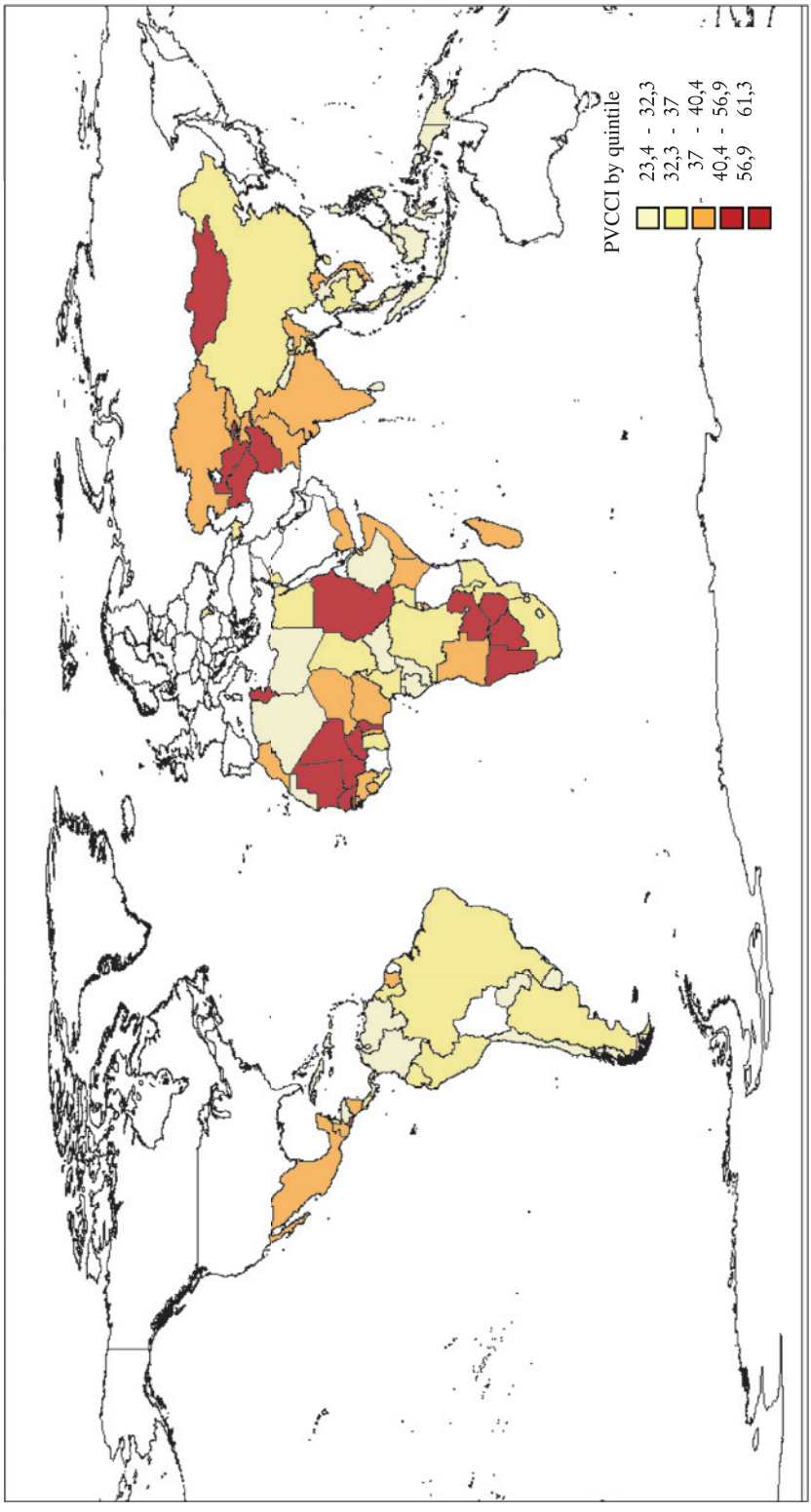


Figure 8.2 PVCCI for developing countries

SIDS–LDCs, noticeably, this high level of vulnerability to progressive shocks is due to sea level rise. For other countries, and noticeably for LLDC–LDCs located in desert areas, the high level of vulnerability is due to the risk of over aridity. For instance, Kiribati and Tuvalu are, with Maldives, the countries of the world that are 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 Asian countries (e.g. Afghanistan, Turkmenistan). Some LDCs also face both types of progressive shock: 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 sea level rise in the Senegal river delta (a similar vulnerability is found in The Gambia).

As for the 'risk of intensification of recurrent shock', this component, which on average is 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 rainfall shocks (Guinea-Bissau, Myanmar, Zambia). Of course, those countries that are among the most vulnerable to the intensification of recurrent shocks are to a large extent vulnerable to both types of shock. A few other LDCs appear to be essentially vulnerable to one kind of shock (Comoros to temperature; Zimbabwe, Malawi and The 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, summarised in Table 8.2, may help in the design of appropriate adaptation policies.

8.2.4 PVCCI and EVI: are the two vulnerabilities correlated?

The UN Economic Vulnerability Index (EVI) has been proposed for use as one of the criteria for 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). Similarly, the PVCCI could be used as one of the main criteria for the allocation of 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 support the idea of two specific assessments of 'needs'.

We compared PVCCI and EVI in 2012 (see Figure 8.3 and Annex 8.4), calculated with both the current and 2009 formulae. As the current formula includes the component 'Share of population in low elevated coastal zones' the EVI 2012 is

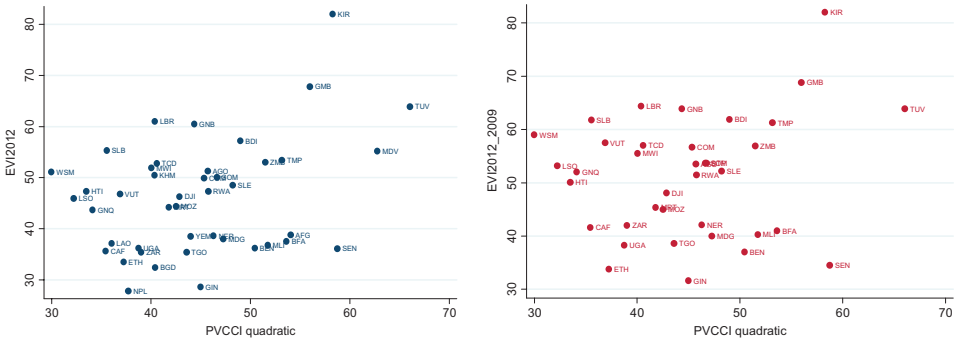
Table 8.2 Various sources of vulnerability to climate change in LDCs

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, The 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

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, which relies on PVCCI and gives an objective and quantitative assessment of the vulnerabilities of the LDCs' category, has shown a greater vulnerability of LDCs compared with other developing countries and an

Figure 8.3 PVCCI and EVI for LDCs



important heterogeneity within the category. These results challenge the choice of appropriate adaptation policies for the LDCs.

8.3 The international support for adaptation since IPoA

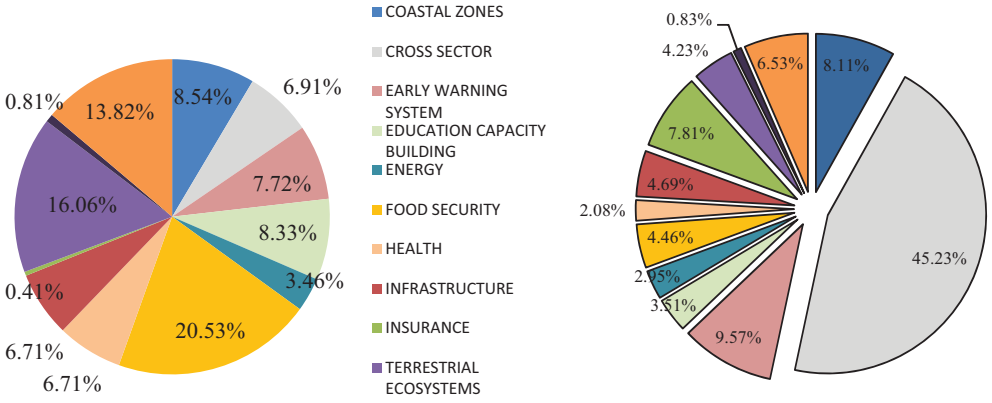
Having in mind the high level and various sources of vulnerability to climate change shown by the LDCs, we now examine what has been the response of the international community in particular for supplying LDCs with adequate adaptation resources. It should be recognised that the change observed since 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 NAPAs. Indeed, many other sources of international finance can contribute to support the adaptation of LDCs to climate change (multilateral development bank, United Nations Development Programme (UNDP), bilateral donors, etc.). But the IPoA underlines two actions we focus on, because they are additional. The IPoA strongly advises LDCs 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 to 'replenish and expedite, as appropriate, the disbursement of funds for adaptation to least developed countries under UNFCCC, including the Least Developed Countries Fund.'

8.3.1 'To mainstream and implement NAPAs'

The NAPAs aim to participate in the development of the country in a way appropriate to the local context. Each project presented in the NAPA must also demonstrate a positive impact on mitigation or attenuation of climate change. Countries have prepared their NAPAs since 2003. In January 2013, the UNFCCC Secretariat counted 47 NAPAs submitted to the Secretariat. The latest NAPA received is from Angola, in December 2011. Cape Verde and Maldives, now no longer LDCs, have NAPAs. Bangladesh is the most advanced LDC in the process, having been the first country to post a NAPA in December 2005. This country now has 15 projects in this framework, ordered by priority. UNFCCC distinguishes 11 sectors and 1 'cross-sectors' category, making clear that adaptation policies are related to all sectors in the economy and often difficult to disentangle from general development purposes.

Based on data collected from the UNFCCC, Figure 8.4 shows that the number of projects is quite balanced, divided according to the type of sector. '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 have the highest costs. From a sectorial perspective, the most costly projects are, on average, in the sectors of 'early warning systems' and 'coastal areas'.

Figure 8.4 Development sector prioritised by project and costs in NAPAs (%)



As NAPAs provide a prioritisation of projects, it is interesting to note that those sectors accounting for the largest share of the costs of NAPAs are also areas of highest priority projects in each country, as shown by their own declarations (see Table 8.3).

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 per project. Regarding the number of projects per country, the largest is in Haïti. Leaving Haiti (a Latin American and Caribbean country) aside, Figure 8.5 particularly emphasises the large number of projects and low-cost countries in sub-Saharan Africa and the Pacific. These countries indeed offer a very large number of projects in all sectors. The number of projects is accompanied by a low-cost way in each case.

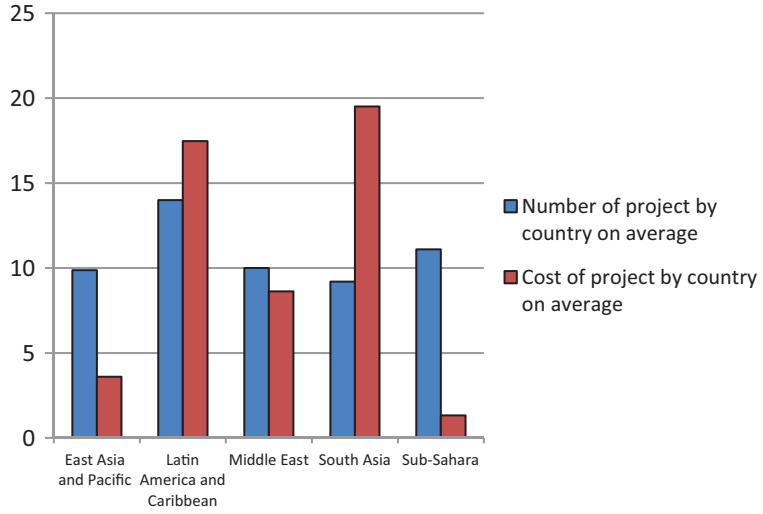
Finally, there does not seem to be any correlation between each country's NAPA indicators, such as the number of projects or the cost of the NAPA, and their vulnerability to climate change as measured by the PVCCI. This result is not surprising,

Table 8.3 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 website, authors' calculations (January 2012 database)

Figure 8.5 Number and costs of project by country



Source: UNFCCC website, authors' calculations (January 2012 database)

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 filed 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 multisectoral (UNFCCC website). The NAPAs also provide a rough assessment of the estimated costs of adapting to climate change. To carry out these projects, financial support of the community is necessary. The LDC Fund is specially devoted to financing adaptation of LDCs to climate change.

8.3.2 'To replenish and expedite the disbursement [...] of the LDC Fund'

In Article 4.9, the UNFCCC recognises the special situation of LDCs. For this purpose the LDC Fund was established in 2001 (during the COP 7). The fund addresses the special concern of the LDCs that are recognised to be especially vulnerable to the adverse impact of climate change. The major action for the LDC fund is to support LDCs in the preparation of NAPAs.

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

seem to be missing in the IPoA, namely 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 a very partial substitute for such indicators, we wonder whether the adaptation funds disbursed in the direction of LDCs seem to respond to their physical vulnerability to climate change.

8.3.3 Is there a link between LDC Fund disbursements by country and the country's physical vulnerability to climate change?

In June 2012, USD 537 million had been pledged to the LDC Fund. Germany, the United Kingdom, the United States, Sweden and Denmark are the five main contributing countries. Germany's contribution is twice that of the second donor.

Official 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 USD 26 billion in 2012. In the same year, the amount of grants from the LDC Fund was USD 86 million. From the beginning, the LDC Fund supported 74 projects in 44 countries, totalling USD 334.6 million and leveraging USD 1.59 billion in co-financing. The most important aim of the fund is to finance the preparation and implementation of NAPAs. As of June 2012, USD 346 million has been approved for projects and enabling activities. Since its inception, the LDC Fund 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 projects. Preparation of NAPAs is for LDCs one of the main objectives of IPoA in relation to climate change.

At first glance, there is no simple correlation between the level of the PVCCI and the accumulated LDC Fund grants, as shown in Figure 8.6. But of course the allocation of these grants is likely to depend on the other usual factors of aid allocation, primarily the level of income per capita and the population size.

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

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

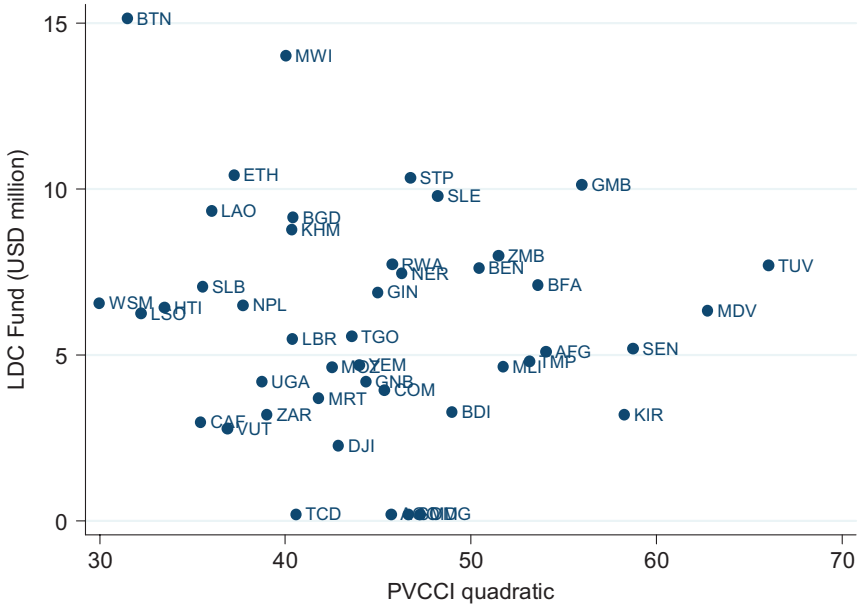
$$\text{Log}\,(G_i) = \alpha + \beta_1 \text{PVCCI}_i + \beta_2 \text{Log}\,(\text{GNI}_i) + \beta_3 \text{Log}\,(\text{GNI}_i)^2 + \beta_4 \text{Log}\,(\text{Pop}_i) + \varepsilon_i$$

where:

G = grants amounts of LDC Fund in US constant dollars

PVCCI = index of physical vulnerability to climate change, as described above

Figure 8.6 LDC Fund grants (all projects) and PVCCI



Source: Authors' calculation

GNI = gross national income

Pop = population

PPG = Project Preparation Grants by the LDCF (in US dollars)

All data refer to 2012, and come from the World Development Indicators database. The amounts of grants data come from the Global Environment Facility (GEF) database.[5] Table 8.4 presents some results of the estimations, which are still very tentative. We obtain a positive but not significant impact of the vulnerability index on the grants, the more significant (i.e. the less not significant) being when grants are considered with their co-financing. In column 1 the coefficient is not significant. Finally, the coefficient is close to significance 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.

When we introduce each sub-component of the PVCCI (Table 8.5), only the component 'sea level rise' is significant and positive, and then only for the 'grants of LDCF for all projects' and for 'LDCF grants and co-financing projects'.

While, by definition, the adaptation resources mobilised by the LDC Fund are directed at the countries that are among the most vulnerable in the world, these

Table 8.4 LDC Fund grants and PVCCI

	(1)	(2)	(3)
Variables	**LDC Fund grants and co-financing projects**	**LDC Fund grants, all projects**	**LDC Fund 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; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; $^{+}p < 0.15$

Table 8.5 LDC Fund grants and PVCCI by components

	(1)	(2)	(3)
Variables	**LDC Fund grants and co-financing projects**	**LDC Fund grants, all projects**	**LDC Fund 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; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; $^{+}p < 0.15$

Table 8.6 LDC Fund grants by sector and PVCCI by components

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**Food security and agriculture**	**Water resources**	**Early warning systems**	**Coastal management**	**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; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; $^{+}p < 0.15$

results indicate that within this group there is 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 sea level rise seems to have an impact.

Let us now divide the grants received by each country by sector (Table 8.6); the estimations are rather weak, since data are rare. However, these preliminary results show a possible positive relationship between the kind of vulnerability faced by each country and the kind of project funded. The choice of project seems to be in line with the vulnerability of the country.

The second part of this study compared adaptation policies adopted by the LDCs through 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 NAPAs since May 2011 (except Equatorial Guinea, Myanmar and Uganda), and the LDC Fund has increased significantly its grants towards the countries. But this section also shows a weak correlation between adaptation grants and the countries' 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 to other developing countries as well.

8.4 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 reference to an assessment of the level and nature of the country's 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 each country. Because, through its components, it shows 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 for the allocation of international resources available for adaptation.

This chapter has shown the relatively high vulnerability of LDCs to climate change and its main sources. It has also examined the advancement of 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, which has been of only a part of these resources. One should recognise the difficulty of assessing 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.

Annex 8.1 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 nationally appropriate mitigation actions (NAMAs) and the transfer of such technologies under mutually agreed terms;

(*continued*)

Annex 8.1 Actions relative to climate change in the IPoA (continued)

(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 the United Nations Framework Convention on Climate Change (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 operationalisation of the Green Climate Fund [...];

Action by development partners

(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 NAPAs, medium- and long-term national adaptation plans and 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

Annex 8.2a PVCCI quadratic, by group of countries (1/2, *extension of Table 8.1*)

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	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-income countries (LICs) and lower middle-income countries (LMICs)	84	33.98	30.43	15.82	88	6.70	0.84	21.22	91	45.64	40.70	19.00
LICs and LMICs, non-LDCs	39	34.49	32.18	14.72	41	5.59	1.00	17.06	45	48.48	45.49	19.28
Small island 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 LICs and LMICs	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 LICs and LMICs	8	35.43	29.99	22.31	8	13.81	1.26	34.88	8	40.51	30.72	23.57

(*continued*)

Annex 8.2a PVCCI quadratic, by group of countries (1/2, *extension of Table 8.1*) (continued)

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
Latin American 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
Haïti	1	23.72	23.72		1	2.28	2.28	–	1	33.48	33.48	–
Latin American and Caribbean LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	6	40.49	40.93	12.79	6	2.41	1.83	2.32	9	61.58	65.51	15.88

Annex 8.2b PVCCI quadratic, by group of countries (2/2, *extension of Table 8.1*)

Group of countries	Number of countries	Increase in recurrent shocks			Rainfall shocks			Temperature shocks		
		Mean	Median	Standard deviation	Mean	Median	Standard deviation	Mean	Median	Standard deviation
All developing countries	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-income countries (LICs) and lower middle-income countries (LMICs)	95	49.19	49.21	7.66	45.71	45.60	10.73	51.37	48.11	10.71
LICs and LMICs, non-LDCs	47	46.35	45.52	6.61	43.45	43.25	8.86	48.26	45.63	9.55
Small island 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 LICs and LMICs	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 LICs and LMICs	8	48.89	49.76	4.72	50.26	50.56	9.58	46.97	46.61	2.79
Latin American and Caribbean developing countries	27	46.33	44.98	7.15	39.97	38.81	6.56	51.15	46.26	11.86

(*continued*)

Annex 8.2b PVCCI quadratic, by group of countries (2/2, *extension of Table 8.1*) (continued)

Group of countries	Number of countries	Increase in recurrent shocks			Rainfall shocks			Temperature shocks		
		Mean	Median	Standard deviation	Mean	Median	Standard deviation	Mean	Median	Standard deviation
Haïti	1	40.98	40.98		34.93	34.93		46.26	46.26	
Latin American and Caribbean LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	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 LICs and LMICs	9	43.74	42.66	5.11	39.68	38.14	6.93	46.96	43.57	7.49

Annex 8.3 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 Republic	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, Democratic Republic of the	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, The	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 Democratic Republic.	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

(*continued*)

Annex 8.3 PVCCI quadratic by countries (continued)

	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
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
São Tomé 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, United Republic of	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

Annex 8.4 Ranking comparison between EVI and PVCCI

	EVI 2012	Rank (1)	EVI 2012 (Basis 2009)[a]	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 Republic	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, Democratic Republic of the	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, The	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 People's Democratic Republic	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

(*continued*)

Annex 8.4 Ranking comparison between EVI and PVCCI (continued)

	EVI 2012	Rank (1)	EVI 2012 (Basis 2009)[a]	Rank (2)	PVCCI quadratic	Rank (3)	Rank variation (3-1)	Rank variation (3-2)
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
São Tomé and Principe			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 et al. 2014

Notes

1 The substance of this chapter has been presented at the LDC IV Monitor Expert group meetings in Dhaka (September 2012) and Dar EGM, Dar Es Salaam (February 2013), and in 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 their being responsible for any opinion expressed or possible errors in the present chapter.

2 Among various instability indices, the Notre Dame Global Adaptation Institute Index (NDGAIN 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.

3 Data on the exposure of dry lands come from the United Nations Development Program/ 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 WorldResources Institute website.

4 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.

5 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 dollars, 2000). We also controlled for EVI in 2012, calculated with the old previous 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 with the amount of grants, without clearly modifying the result for the impact of PCCVI.

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