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A note on including climate change adaptation in an international scheme

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Executive summary

Climate change will modify the environment in which people live and economic activities take place. In particular, this change will require an adaptation of economic activities to maintain their productivity, or sometimes a change in activity when no adaptation measure can compensate for environmental changes. This adaptation process can reveal costly and, considering the differences among countries in terms of climate change responsibility and adaptive capacity, there are strong ethical justifications for an international scheme in which developed countries provide support and funding to developing countries. This note proposes a few leads to design this scheme.

This note supports the view that an international scheme designed to help developing countries adapt is necessary, but that, in the near future, using a too strict definition of adaptation would not allow the funding of the most useful projects. The most efficient projects to reduce climate vulnerability, indeed, have often development-related benefits that are large enough to justify their implementation even in absence of climate change. There are not, therefore, adaptation projects in the strictest sense, but they may be the most able to reduce future impacts of climate change. These projects, in spite of their benefits, are not always implemented because of insufficient funding. An international support to adaptation should make these investments possible, thereby reducing future climate vulnerability.

The most specific projects, designed to respond exclusively to a precise change in climate, may be impossible to conceive in the very next decades, because of the large uncertainty in future climates at the local scale. In such a context, broader measures and policies designed to reduce climate vulnerability should be preferred.

Over the next decades, moreover, climate change is likely to remain limited, and most of the impacts are expected in the second half of this century. What is most needed from a climate-change perspective, therefore, is to prepare economies to cope with larger climate-change impacts over the medium to long term. Development is very efficient to do so.

Also, it is critical that climate-sensitive development investments, which are carried out today for non-climatic reasons, take into account climate change to avoid being ill-adapted and requiring retrofitting in the future. This need also supports the inclusion of development investments in our definition of adaptation investments.

In developing countries, adaptation aid can also rely on technology transfers. Debates about technology transfers for mitigation purposes should be extended, therefore, to include adaptation technologies.

As a consequence, this note promotes an international scheme that would support adaptation measures, defined in the broadest sense, i.e. as "*measures that reduce the vulnerability to climate conditions, i.e. the welfare losses potentially caused by climate or weather conditions (including current climate extreme events).*" Stricter definitions are likely to lead to "anti-selection," i.e. to the rejection of the most efficient strategies to cope with climate change.

With such a view, many development actions can be labelled as adaptation, and can be – at least partly – funded by an adaptation international scheme. An adaptation international scheme, therefore, can be viewed as an addition to traditional ODA, and will be referred to as "Adaptation-Driven ODA" or "Official Adaptation-Driven Development Fund."

The difference between this adaptation-driven development fund and normal ODA is twofold:

(i) The adaptation-driven development fund is directed in priority toward the most climate-vulnerable countries and sectors, and supports only projects that reduce the vulnerability to climate change and weather extreme events.

(ii) The adaptation-driven development fund is additional to ODA; it is funded through specific channels, explicitly distinct from ODA channels; and the contribution of each country can be defined by climate-related criteria (e.g., through a carbon tax or a tax on air travel).

The clear separation of funding sources and channels should ensure that the creation of this adaptation-driven development fund does not lead to a reduction in normal ODA.

Possibly, adaptation funding could also focus on specific sectors, where insufficient funding is a constraint in the present situation, and where additional investments would reduce climate vulnerability and bring

immediate benefits in terms of safety, health, and sustainable development. Examples of such sectors are water (drinking, sewage, sanitation, treatment), where $50 billion USD per year are missing to reach the 2015 U.N. Goals, and disaster risk reduction, especially in urban environments.

This note also reviews the published assessments of adaptation costs. Top-down approaches suggest that adaptation costs in developing countries will lie between US$4 and 109 billions per year in the next decades, while bottom-up approaches suggests that these costs will be much lower. In addition to serious methodological problems, this difference between top-down and bottom-up assessments arises from a difference in the definition of what is adaptation, top-down approaches using a broad definition of adaptation while bottom-up approaches use a stricter definition.

The limitations of all costing methodology must be taken into account in the discussion, as it is still out of our reach to assess the cost of adaptation (and residual impacts). Flexibility must, therefore, be introduced in any adaptation scheme, to make sure that it can cope with (positive or negative) surprises in the future.

Finally, the investigation of risk reduction investments in developing and developed countries shows that many risk reduction projects are not implemented, even when benefits largely exceed costs. Funding, therefore, is only one of the obstacles to climate adaptation, and investigating and overcoming other obstacles and barriers will be crucial to succeed in limiting climate change impacts.

Introduction

Climate change will modify the environment in which people live and economic activities take place. In particular, this change will require an adaptation of economic activities to maintain their productivity, or sometimes a change in activity when no adaptation measure can compensate for environmental changes. This adaptation process can reveal costly and, considering the differences among countries in terms of climate change responsibility and adaptive capacity, there are strong ethical justifications for an international scheme in which developed countries provide support and funding to developing countries. This note proposes a few leads to design this scheme.

Adaptation definition

The first issue is to define adaptation. Several definitions can be proposed, from the strictest to the broadest (see Table 1):

- Strictly speaking, an adaptation measure is a change in practice, decision-making, or investment, which is introduced only because of observed and projected climate change (Def 1).
- This definition can be extended to include responses to current climate variability: an adaptation measure can be defined as a change in practice, decision-making, or investment, which is introduced only because of observed and projected climate change or to cope with climate variability (including extreme events in the current climate) (Def 2).
- Starting again from Def. 1, the definition can also be extended to measures for which the reduction in climate change vulnerability is only a co-benefit: an adaptation measure can be defined as a measure that reduces the vulnerability to climate change, i.e., the welfare losses potentially caused by climate change (Def 3). With this definition, a measure that is implemented for non-climatic reasons, but that yields benefits from a climate-change point-of-view is considered as an adaptation measure.
- The broadest definition includes all dimensions: an adaptation measure can be defined as a measure that reduces the vulnerability to climate conditions, i.e. the welfare losses potentially caused by climate or weather conditions (including current climate extreme events) (Def. 4). This last definition is much larger, as it includes all measures that aim at reducing climate-related losses (including losses due to natural climate variability).

Sometimes, an adaptation project according to Def. 3 can be separated into a "non-adaptation" project (that yields benefits in the current climate) and a Def. 1 adaptation projects (that yields benefits only because of climate change). For instance, implementing coastal protections in a city is often beneficial in the current climate, but the dikes have to be made higher because of future climate change. In such a situation, the project

"implementing coastal protections" (an adaptation project according to Def. 3) can be separated into (1) "implementing coastal protections for current sea level" and (2) "making protection higher because of climate change" (an adaptation project according to Def. 1). The same is true for Def. 2/Def. 4 projects. However, such a distinction is often not possible for conceptual reasons (e.g., improvement of health-care system); methodological reasons (e.g., improvement of building norms to cope with extreme events); or because of the uncertainty on future climate change (e.g., the uncertainty on future sea level rise, and on the additional height of flood defences needed because of climate change). Practical difficulties thus arise in distinguishing and financing the component purely related to climate change in any project.

Importantly, all these definitions differ from what is often referred to as "mainstreaming," because they refer to specific projects, not to unspecified alterations of normal policies. Therefore, while it is difficult to identify what is mainstreaming, and to measure the corresponding costs, the adaptation measures defined here can be identified, described, and economically assessed.

Table 1: Four definitions of adaptation, from the strictest (Def. 1) to the broadest (Def. 4)

Climate change only or Climate change and variability Climate is the main justification or not	Climate change only (including future extreme events)	Climate change and variability (including extreme events in the current climate)
Climate is the main justification of the action	Def 1	Def 2
Other benefits are sufficient to justify the action; the reduction in climate vulnerability is a co-benefit.	Def 3	Def 4

Moreover, a positive aspect of including current extreme events and natural disasters in the adaptation framework (i.e. using Def. 2 or 4) is that it makes pointless the inconclusive debate about the link between current events and climate change. With such a scheme, there is no need to know whether or not a drought is *due to* climate change to use an adaptation fund to implement measures to cope with it. This is important, because we know that no answer can be made to this question, since a single event is never due only to climate change (natural variability also plays a role).

Adaptation aid is not compensation[1]

The distinction between adaptation aid and compensation is very important, because the most adequate tools are not the same whether one wants to support adaptation actions in developing countries or wants to compensate the climate-change losers for the losses arising from the activities of other countries.

Adaptation aid is a support by developed countries to developing countries to help the latter adapt to climate change, independently of any responsibility concept (in the same way as ODA is supposed to support the development of developing countries). Compensation is a transfer of fund that aims at compensating developing countries for losses *caused by developed countries* (an application of the "polluter pays principle").

The present confusion between compensation and adaptation aid has important consequences. For instance, if an international scheme includes compensation, using loans seems inappropriate. If an international scheme focuses on adaptation aid only (and not on compensation), then loans are an acceptable tool. This is especially true if a broad definition of adaptation is used: if adaptation funding supports

[1] In this document, the term « compensation » does not refer to the « voluntary compensation » of GHG emissions, but to the financial compensation of losses incurred by someone as a result of the actions of someone else.

development, indeed, the non-climate-related benefits in terms of GDP growth may make it possible to reimburse loans. If adaptation and compensation are mixed in the scheme, then direct transfers only will be accepted.

Table 2: Pluses and minuses for each definition of adaptation measures

Definition	Pluses	Minuses
An adaptation measure is a change in practice, decision-making, or investment, which is introduced only because of observed and projected climate change (Def 1) e.g., building artificial flood defences where natural defences were sufficient without climate change.	- Strict definition of adaptation. - This reduced scope avoids confusion about what is an adaptation project. - Subprojects devoted to climate-change adaptation can sometimes be "extracted" from broader development projects.	- All measure benefits are delayed far in the future, as climate changes. - It is difficult to find projects that are justified only by climate change and to assess the "additionality" of projects, i.e. the additional benefits yielded by the project exclusively because of climate change. - It is politically and ethically difficult to disregard the vulnerability to current climate conditions. - Risk of anti-selection: because measures that yield large benefits without climate change are excluded, the most efficient and useful projects may be rejected (e.g., sanitary sewers).
An adaptation measure can be defined as a change in practice, decision-making, or investment, which is introduced only because of observed and projected climate change or to cope with climate variability (Def 2). e.g. building artificial flood defences where natural defences are not sufficient in case of storm.	- Such adaptation strategies would provide immediate side-benefits, like natural risk reduction and improved infrastructure services. - It is easy to find projects satisfying this definition.	- May be used to fund projects useful to cope with climate events, without any relation with climate change: the adaptation focus may finally get lost. - Risk of anti-selection: because measures that yield large benefits without climate change or climate extreme events are excluded, the most efficient and useful projects may be rejected (e.g., sanitary sewers).
An adaptation measure can be defined as a measure that reduces the vulnerability to climate change, i.e., the welfare losses potentially caused by climate change (Def 3). e.g., investing in sanitary sewers, that yield large benefits in terms of health, where heavy precipitations are expected to increase.	- Such adaptation strategies would provide immediate and large side-benefits, like natural risk reduction and improved infrastructure services. - Allows to fund the most efficient projects to reduce climate change impacts. - It is easy to find projects satisfying this definition.	- Many infrastructure and development projects can be considered as adaptation projects with this definition, but adaptation funds will be too small to fund all of them. Need to find additional criteria to select projects. - In some countries, the top-priority is to cope with present-day climate events. The most useful projects may be those dealing with these events, not with climate change. - It is politically and ethically difficult to disregard the vulnerability to current climate condition.
An adaptation measure can be defined as a measure that reduces the vulnerability to climate conditions, i.e. the welfare losses potentially caused by climate or weather conditions	- Such adaptation strategies would provide immediate and large side-benefits, like natural risk reduction and improved infrastructure services.	- Many infrastructure and development projects can be considered as adaptation projects with this definition, but adaptation funds will be too small to fund

(Def 4). e.g., investing in sanitary sewers, that yield large benefits in terms of health, and reduce the vulnerability to heavy precipitations in the current climate (even if these precipitations are not expected to increase because of climate change).	- Allows to fund the most efficient projects to reduce climate and climate-change impacts and to cope with present-day issues. - It is easy to find projects satisfying this definition.	all of them. Need to find additional criteria to select projects. - May be used to fund projects useful to cope with climate events, without any relation with climate change: the adaptation focus may finally get lost.

Adaptation costs are different from compensation amounts. The adaptation cost is determined from the investments needed to mitigate the loss of income; compensation is determined from the impact of climate change, i.e. from the loss of income due to climate change, including adaptation expenditures. In other terms, compensation amounts are equal to climate change costs, i.e. to the sum of adaptation costs and residual impacts.

If an economic activity becomes unprofitable (e.g., tourism in hot regions), one talks about adaptation costs when considering the funding needed to create new activities to replace the lost one; one talks about compensation when considering the loss of income due to climate change. When adaptation cannot compensate climate change effects (i.e., when adaptation cannot cancel out impacts, i.e., when there are residual impacts), the amount subject to compensation is larger than adaptation costs.

In many situations, it would be difficult to consider only adaptation and disregard compensation, especially where adaptation is inefficient. For instance, if small islands are to be lost because of sea level rise, and if no adaptation strategy is available, it appears impossible not to provide any support to the affected population (e.g., climate refugees) on the basis that 'adaptation is not compensation'. The first decision that will need to be made concerns the balance between adaptation aid and compensation. *Making the distinction between adaptation aid and compensation perfectly clear in the scheme would make it easier to find a compromise.*

What is needed now?

If an international scheme on adaptation is put in place in the next ten years, it should focus on the adaptation measures that will be most needed in the very next decades. This section, therefore, analyses the most pressing needs that should be considered in priority.

Over the next decades, climate change is likely to remain limited, and most of the impacts are expected in the second half of this century. What is most needed from the climate-change perspective, therefore, is to prepare economies to cope with larger climate-change impacts over the medium to long term. This can be done through two interacting channels: development, and infrastructure development.

Adaptation and development

Adaptation is a different thing in developed countries, where the vulnerability to weather conditions is mitigated by well-developed infrastructure, and in developing countries, where these infrastructures are not present.

In developed countries, adaptation will require an upgrade or replacement of some infrastructure, which is a costly action carried out only because of climate change. In this case, identifying adaptation measures is easy.

In developing countries, the vulnerability to current climate variability and weather events is large because infrastructures are not in place to mitigate their impacts. For instance, there is no water storage and irrigation infrastructure to cope with drought in the agriculture sector; there is no drainage infrastructure to cope with heavy precipitations in urban areas.

In this situation, development is likely to be the most efficient adaptation strategy, and most adaptation strategies will include the development of infrastructures, which are beneficial even in absence of climate change because they help cope with climate variability. Water reservoirs are useful to cope with rainfall variability in the current climate, and they will also be very useful to cope with climate change. In the design of these new infrastructures, however, it is critical to take into account climate change. Otherwise, these

infrastructures are at risk of being ill-adapted (and possibly useless or dangerous) over the medium to long term.

In developing countries, adaptation aid can also rely on technology transfers. Many technologies that are regularly used in some countries could mitigate climate change impacts in other locations. As an example, water reuse technologies developed in Israel could be very useful if implemented in the entire Mediterranean basin. Debates about technology transfers for mitigation purposes should be extended, therefore, to include adaptation technologies.

In the least developed countries, moreover, adaptation strategies may even have to focus on capacity building and institutional capacity before considering "harder" investments. Institutional capacity, for instance, is a requirement to implement adaptation options based on land-use planning. The ability of the countries to implement in an efficient way adaptation actions – a problem that is often referred to as the "absorptive capacity" issue – should be key in determining which projects will be actually funded.

It will be much more difficult to distinguish "development actions" and "adaptation actions" in developing countries, and especially in the least developed countries. In other words, we will find many adaptation measures in developing countries that fit with Def. 2, 3 or 4, but few that are desirable only because of climate change, i.e. that fit with Def. 1. Moreover, the few measures consistent with Def. 1 may not be the most efficient to cope with climate change over the long-term: selecting measures that are justified by climate change only is likely to induce "anti-selection," leading to the rejection of the most cost-effective policies. The broader definition of adaptation should, therefore, be promoted.

Also, adaptation measures in the Def. 1 definition are measures that will yield most of their benefits far in the future as the climate changes, while least developed countries have urgent needs in many domains, including risk reduction, health care, education, housing, and infrastructure development. Using Def. 2 may answer the need for risk reduction investment. Using Def. 3 may answer the need for investment in health care, education, housing, and infrastructure development. But only Def. 4 would allow the funding of all the projects that have the largest immediate non-climate benefits and that are likely to be the most efficient to reduce climate vulnerability in the future. *Def. 4, therefore, seems to be the most adequate definition for the short-term period. In a more distant future, immediate adaptation needs may make necessary to re-focus adaptation funding, and a stricter definition may become necessary. This is not the case yet.*

On which sectors an international scheme should focus?

An international scheme on adaptation should focus on the adaptation measures that will be most needed in the next 20 years. Over this period, climate change is likely to be quite limited, and should not require a large transformation of economies and infrastructures. So, adaptation measures (in the strictest sense, i.e., Def.1) that need to be introduced in the next 20 years are those that cannot be introduced efficiently when climate change impacts will materialize, but that need to be introduced with anticipation.

First, development can reduce climate vulnerability, but development is a medium to long term process that cannot act instantaneously. Second, infrastructures have a long lifetime, and adapting infrastructure to climate change cannot be done rapidly: anticipation will be essential. For instance, urban forms cannot be modified over less than a few decades: if an efficient strategy is to have different urban structures in 2050, then appropriate policies must be introduced in the next 20 years. In the same way, many developing countries are investing a lot in new long-term infrastructures (water management, energy production and distribution, transport infrastructures). If these infrastructures are to be adapted to a new climate in 2050, this new climate needs to be taken into account from now. So, it is critical that climate-sensitive development investments, which are carried out today for non-climatic reasons, take into account climate change. Otherwise, these infrastructures may require expensive retrofit in the future to avoid becoming ill-adapted (and often dangerous in case of risk reduction infrastructures). This point supports the inclusion of climate-sensitive development investments in our definition of adaptation investments (Def. 4).

Table 3 shows the sectors where development investments are climate sensitive, and where adaptation measures will be most needed in the next 20 years, to be able to cope with climate change later in the century[2].

[2] Hallegatte, 2008, Adaptation to Climate Change: Do Not Count on Climate Scientists to Do Your Work, Reg-Markets Center, Related Publication 08-01, available on http://www.centre-cired.fr/spip.php?article558.

Table 3: List of sectors in which adaptation measures should already be implemented, because of their investment time scales and their exposition to climate conditions. In this table, exposure is estimated empirically by the author.

Sector	Time scale	Exposition
Water infrastructures (e.g., dams, reservoirs)	30–200 yr	+ + +
Land-use planning (e.g., in flood plain or coastal areas)	>100 yr	+ + +
Coastline and flood defences (e.g., dikes, sea walls)	>50 yr	+ + +
Building and housing (e.g., insulation, windows)	30–150 yr	+ +
Transportation infrastructure (e.g., port, bridges)	30–200 yr	+
Urbanism (e.g., urban density, parks)	>100yr	+
Energy production (e.g., nuclear plant cooling system)	20–70 yr	+

The complexity of adaptation: the need for flexibility

Adaptation measures are sometimes very specific, because of local specificities. For instance, climate change is likely to make some productions unprofitable (e.g., crop production or tourism). In countries or regions which are heavily dependent on an economic sector that may be threatened by climate change, economic diversification is a very relevant (long-term) adaptation strategy.

Also, expectations about future climate change may change investment decisions, even in sectors that are not related to climate change. Investors, indeed, can be reluctant to invest in very vulnerable locations (e.g., small islands) because climate change makes their long-term viability questionable. For instance, the current loss of land in many small islands (e.g., Tuvalu) is due to inadequate investment decisions that increase erosion, not to climate change. In absence of climate change, however, ambitious and expensive protection measures could be implemented to protect the coast. With climate change, however, it is very likely that these protection measures will not be able to protect the coast for ever, making the investment benefits too uncertain to be funded. In such a situation, climate change is not responsible for the damage, but climate change makes it impossible to implement the measures that are needed to cope with it. Sometimes, investments undertaken to cope with environmental damages should be considered as adaptation investments, even though the cause of the damages is not climate change.

Some strategies could be included in adaptation plans, even though they may first appear only remotely related to climate change (e.g., the development of a manufacturing sector in a region where tourism is the main source of income). To be able to include these strategies in an international scheme, it should be designed in a flexible way, allowing very specific measures linked to localized needs to get supported.

The case for the broadest definition of adaptation

As a conclusion, it seems that using the broadest definition of adaptation (Def. 4) allows the funding of the projects that are both the most efficient to reduce climate vulnerability over the medium to long term, and the most needed and useful over the short term. This definition, therefore, should be promoted. With such a

definition, adaptation funding can be considered as an "adaptation-driven ODA," which funds development actions that are selected for their co-benefits in terms of climate-vulnerability reduction. The corresponding fund can be referred to as an "Official Adaptation-Driven Development Fund."

Adaptation costs, sources and assessments

Of course, the amounts involved in the scheme will have to be significant compared with the needs for adaptation funding. This section investigates and identifies the sources of these costs, summarizes the available assessments, and emphasizes their limitations.

Sources of adaptation costs.

Sometimes, the optimal investment strategy in a sector is the same with and without climate change, but the investment benefits are made larger by climate change (e.g., this is the case for water reservoirs). In this case, there is no adaptation cost, only benefits, and one needs to investigate adaptation barriers, not adaptation costs. Looking at risk reduction investments, it is obvious that many projects are not implemented, even when benefits largely exceed costs. Funding, therefore, is only one of the obstacles, and investigating and overcoming other obstacles and barriers will be crucial.

Sometimes, the optimal strategy is different because of climate change (e.g., higher dams and levees in coastal areas). In the latter case, the new strategy is sometimes (but not always) more expensive and can be associated to adaptation costs.

It is important to identify the cases where the changes made necessary (or profitable) by climate change can be associated with an additional cost. It is important to note that many adaptation actions can be introduced at no- or low-cost, provided that investment lifetimes are shorter than climate-change timescales. For instance, if climate change makes it necessary to grow different crops in a region, the cost is almost zero if the shift can be done when the equipment (that is required to grow the initial crop) has to be retired anyway. In such a situation, initial investments are not lost; and new investments can be undertaken taking into account the change in climate.

However, additional costs can arise from five (non-independent) sources[3]:

1- *When climate change makes new investments necessary*. This is the case, for instance, where irrigation is not currently present but will be made necessary by climate change; or where natural coastal defences will have to be replaced by man-made defences.

2- *When climate change increases the cost of investments*. This is the case where coastal defences – needed in the current climate – will have to be made higher because of sea level rise.

3- *When climate-sensitive investments have a long life-time compared with the climate change time scale*. Climate change adaptation does not mean adapting to a new stabilized climate. It means adapting to a climate in constant evolution, which is more difficult and more costly. For instance, many buildings that are designed today are supposed to last (at least) up to 2080. Even if it is not more difficult or more expensive to design a building adapted to the 2080s' climate than to the current climate, it may be more expensive to build a building adapted to the range of climates that the building will experience over the decades (or to retrofit it along its lifetime or to replace it earlier than initially planned). For long-lived infrastructures, climate evolution will create additional investment costs through reduced investment lifetime or continuous retrofit.

4- *When uncertainty on future climate makes it necessary to make investments more robust to many possible climates*. For instance, future precipitations are very difficult to predict. If a dam is built today, it will have to be adapted to the precipitations of the 2080's (and even of the 2150's). Since these precipitations are largely unknown (in many regions, climate models disagree even on the sign of future precipitation changes), it may reveal necessary to design the dams in such a way that it is able to cope with the most pessimistic

[3] Hallegatte, 2008, Adaptation to Climate Change: Do Not Count on Climate Scientists to Do Your Work, Reg-Markets Center, Related Publication 08-01, available on http://www.centre-cired.fr/spip.php?article558; and Hallegatte, S., 2007: Do current assessments underestimate future damages from climate change? *World Economics*, **8**, 131–146.

projections, which can be very costly. In a few decades, we may realize that many of such additional investments have been realized but were finally not needed, because climate change is not as large as the most pessimistic projections suggested. But it does not mean that, with our current knowledge, taking into account these very pessimistic projections is not rational. In such a case, this is not the actual change in climate conditions that is costly, but the increase in uncertainty that makes optimization methods less efficient and investments more costly.

5- *When economic activities can become unprofitable because of a change in climate conditions.* For instance, economies based on agriculture production (and especially on the export of a single commodity) can be heavily impacted if this production becomes inefficient and unprofitable. Countries that rely on tourism may have the same problem if their attractiveness is reduced. In this case, adaptation costs consist of (i) social costs to help the most affected households and regions; and of (ii) the investment aid needed to create new activities to replace the unprofitable one. Past experiences have shown how high social costs can be when a region loses an important source of income (e.g., deindustrialization in some regions in Europe and the U.S.).

These sources of adaptation cost also support the use of a broad definition of adaptation. The most specific projects designed to respond to a precise change in climate (i.e. Def. 1 projects) may be impossible to conceive because of climate change uncertainty. In such a context, broader measures and policies designed to reduce climate vulnerability must be promoted.

Moreover, there is a risk that the focus on financial transfers makes developing countries focus on costly adaptation measures and disregard other measures. This focus would be a mistake, as many (no- or low-cost) institutional or governance changes can reveal extremely effective in mitigating climate change impacts.

Available Assessments

Two types of adaptation cost assessments are available. The first type is based on a top-down approach, starting from total investments. Such assessments have been proposed by the World Bank, the UNFCCC and NGOs (e.g., Oxfam). The second type is based on a bottom-up approach, starting from NAPAs or from studies at the sector scale.

An excellent review on these topics is available in the OECD report "Economic Aspects of Adaptation to Climate Change", by Agrawala and Fankhauser (2008).

Top-down approach. Adaptation cost assessments have been carried out by the World Bank (2006), the Stern Review (2006), Oxfam (2007), UNDP (2007) and UNFCCC (2007). The time horizons that have been considered are today for the World Bank, the Stern Review and Oxfam; 2015 for UNDP and 2030 for UNFCCC.

The estimates for the total cost of adaptation lie between $4 and $109 billion per year, for developing countries only. Only the UNFCCC provides an assessment at the global scale, between $44 and $166 billion per year. These estimates must be considered with care, considering the way they have been produced.

All of these assessments follow a very simple methodology: they assess the amount of investments and their sources (gross domestic investment (GDI), foreign direct investment (FDI), and official development assistance (ODA)). Each of these investments has a fraction that is assumed climate sensitive (e.g., according to the World Bank, 40% for ODA, 10% for FDI, and 2-10% for GDI). It is then assumed that the climate sensitive fraction of investment can be made robust to climate change (climate-proofing of investments) at a cost, which represents approximately 5 to 20% of the total cost. This climate-proofing cost is what is referred to as the cost of adaptation. The various assessments differ by their choices in terms of climate-sensitive fraction and of climate-proofing cost. If is unclear where these assessments come from.

The adaptation costs proposed by these top-down assessments seem consistent with the broadest definition of adaptation (Def. 3 or 4), and to include development actions able to reduce climate vulnerability. Regardless, all available assessments appear extremely weak.

Bottom-up approach. Another way of assessing adaptation costs is to start from specific projects. NAPAs, for instance, provide sets of adaptation measures that can be evaluated. It is unlikely, however, that NAPAs can be used to assess global adaptation costs, because of the lack of consistency among them, and their lack of comprehensiveness.

Sectoral analyses in the scientific literature provide another approach to assess adaptation costs. For instance, many studies have investigated the additional cost of coastal protection, and shown that these costs are significant but small in terms of national GDP, even though they can represent a large share of local coastal

GDP. These studies should also be used with care because of numerous limitations. For instance, in the case of coastal protection, they do not take into account the residual risks, the need for careful maintenance, and the negative consequences on tourism, fisheries and biodiversity. Also, their conclusions seem sometimes at odd with the past experience of difficulties and costs of coastal protection (e.g., in New Orleans, London or the Netherlands). Moreover, all sectors have not been investigated, and no comprehensive estimate of global adaptation costs can be proposed yet.

The adaptation costs proposed by these bottom-up assessments seem consistent with the strictest definition of adaptation (Def. 1), and they do not include development actions. So, the difference between top-down and bottom-up assessments is likely to arise from a difference in the definition of what is adaptation.

As a conclusion on adaptation costs, the limitations of all costing methodology must be taken into account in the discussion. It is still out of our reach to assess adaptation costs. Therefore, flexibility must be introduced in the scheme to make sure that it can cope with (positive or negative) surprises about adaptation costs.

Funding adaptation measures in developing countries

There have been long discussions about the best way of funding adaptation actions in developing countries. Two questions need answers: on the one hand, who should pay, how, and how much? On the other hand, who should get helped, and for which projects?

If a broad definition of adaptation is retained (Def. 3 or 4), the distinction between adaptation funding and ODA becomes fuzzier. The risk is to fail ensuring the additionality of adaptation funding, i.e. to see a reduction in ODA in response to the increase in adaptation funding. To make a clear distinction between the adaptation-driven development aid and normal ODA, it is thus essential:

(i) to create specific funding sources and channels, which are clearly distinct from normal-ODA sources and channels, and can overcome political pressures in developed countries;

(ii) to set strict criteria on who should pay, how, and how much; these criteria may (but do not have to) include climate-related indicators (e.g., past emissions);

(iii) to set strict criteria on who should get help, and for which projects and which amounts; these criteria must take into account climate-related indicators, including climate-vulnerability and adaptive capacity.

These points are discussed in this section.

Who should pay, and how?

The possible criteria to decide about who should help pay for the adaptation in developing countries are the following:

- The funding should be 'new and additional' with respect to previous official development aid (ODA). In particular, ODA should not be reduced to fund adaptation projects.

- The funding should be 'predictable' and 'stable', to allow for strategic planning within countries.

- The funding should be 'equitable', i.e. should take into account the capacity to pay and, possibly, the responsibility in past emissions.

These criteria help propose strategies to raise funds for adaptation in developing countries. First, to avoid political risks in developed countries, to avoid a crowding-out effect on ODA and to make sure the funding is predictable and stable, the scheme should avoid appearing as a direct transfer from developed to developing countries (and especially to originate from government budgets). Funds raised by international institutions (and appearing as "international money") are likely to be more predictable and stable than bilateral or multilateral funding, which is subject to strong political pressure.

Examples of such fund sources are:

- The taxation of international transportation, by an international organization (e.g., the IATAL proposal);

- The CDM adaptation levy (i.e., the 2 percent levy on the proceeds of the CDM), that could be extended to Joint Implementation (JI) and International Emissions Trading (IET) (e.g., the Norvegian Proposal);

- The Swiss proposal for a 2$/tCO2 on all fossil fuel emissions (with a 1.5tCO2 per inhabitant exemption).

From this perspective, the China proposal "+0.5 of GDP" or the World Bank PPCR do not seem to be the best schemes, since they are too close to traditional ODA to avoid crowding-out effects.

Who should get helped, and for which projects?

A first decision has to be made concerning the governance of the fund. There are two extreme views: (i) the funding decisions are made by the countries that provide the financial resources; or (ii) the funding decisions are made by the countries that are beneficiaries of the fund. The available proposals (the World Bank fund or the Kyoto Adaptation Fund) correspond to various balances between these two extremes. Again, the balance between compensation and adaptation is important: in the case of compensation, the money is owned by the beneficiaries, and funding countries have no right to interfere with how the money is spent; in the case of adaptation aid, the limitation does not hold. This governance can also be done by some existing institution, or by a specifically-created one.

Then, adaptation action can be funded at different scales. Two dimensions are of particular interest: First, international funding can support actions at the national scale, each country being in charge of regional actions, or at the regional scale. Second, international funding can support well-defined projects (private projects in the CDM line or public projects in the ODA line) or support broader policies. The UNFCCC Adaptation Fund seems to have chosen to fund projects, but this choice can be questioned, especially in the least advanced countries where adaptation is more difficult to define. Concerning health, for instance, the optimal adaptation strategy is likely to be a mix of nationwide policies (e.g., water quality regulation) and specific projects (e.g., water infrastructure development).

The previous sections have supported the use of a broad definition of adaptation measures (Def. 3 or 4). The problem is that, with this definition, too many projects would be considered as adaptation projects. For instance, according to some estimates (e.g., Kikeri and Kolo, 2005), improving infrastructure networks and service delivery requires 7.5-9 percent of GDP for low-income countries for the next five years (this corresponds to about US$150 billion). This amount is much larger than what can be expected from a climate-change-adaptation scheme in the near future. So, if an adaptation scheme retains a broad definition of adaptation, it will be necessary to agree on additional criteria to decide which projects will be funded. Many alternatives exist. They involve three choices: (1) which countries can receive support (all developing countries; only the least advances; only the most vulnerable ones, etc.)? (2) Which projects (or policies) will be supported? And (3) which fraction of the project total cost will be paid by adaptation aid ? Hereafter, a few possibilities are proposed:

(i) Funding only a fraction of each project that reduces vulnerability to climate change (Def. 3) or climate change and climate variability (Def. 4) in developing countries. For instance, 10 percent of each project would be funded. This fraction will be determined from the available funding.

(ii) Funding only a fraction of each project that reduces vulnerability to climate change (Def. 3) or climate change and climate variability (Def. 4) in developing countries. This fraction would be estimated from the fraction of benefits that is related to climate change. Such strategy focuses more on adaptation, but creates difficult methodological problems, to measure additional benefits that the project yields because of climate change.

(iii) Funding integrally the projects for which a large fraction of the benefits are related to climate change (Def. 3) or to climate variability and change (Def. 4) in developing countries. The threshold would be determined after projects have been submitted, as a function of available funding.

(iv) Funding integrally all projects that reduce vulnerability to climate change (Def. 3) or climate change and climate variability (Def. 4), but only in the developing countries with the largest vulnerability and the lowest adaptive capacity. The threshold (both in terms of vulnerability and capacity) has to be discussed in detail, as a function of available funding. It is important to note that these countries (most vulnerable, least advanced) are those where distinguishing development actions and adaptation actions is almost impossible, and where support to adaptation is the most needed.

Of course, these strategies can be combined. For instance, it would be possible to focus all efforts on the least advanced countries and to fund 10% of all projects that reduce climate change vulnerability (even projects that are not mainly dedicated to this aim).

One strategy could be to focus the adaptation fund on a specific sector, e.g. which is particularly vulnerable to climate change, plays a role in economic development, and is associated with large benefits even in absence of climate change (e.g., water treatment and sanitation, agriculture and irrigation, natural risk reduction). One can propose:

(i) To fund investment in water infrastructures (including providing drinking water, sewage and sanitation, and treating used water). These investments provide large benefits over the short-term even in absence of climate change (especially concerning health and disaster risk reduction). The Camdessus report (2003) estimated that meeting the 2015 water-related goals of the UN Millenium Declaration would require an additional $17 billion funding per year for water and $32 billion per year for sanitation and sewage. Because these estimates do not take into account resilience to climate change, the needed funding may be somewhat larger, by 5 to 10%. An international adaptation scheme may decide to focus first on providing to developing countries the water infrastructures they need, making sure that these infrastructures are climate-proof. The needed amount would be about $50 billion per year over the next decades. Since international funding of these infrastructure already exists (with average commitment of aid to water and sanitation of $3.1 billion in the 1999-2001 period), the additional funding from adaptation aid would be easy to integrate into already-existing frameworks.

(ii) To fund investments in risk reduction, in spirit of the U.N. Trust Fund for Disaster Reduction and the Global Facility for Disaster Reduction and Recovery. As disasters kill thousands of people every years, affect hundred of millions of people, and cost tens of billions dollars per year, it is well accepted that investing in disaster reduction pays off in the current climate, and that it promotes sustainable development. So, disaster risk reduction investments would yield significant benefits over the short-term, and even in absence of climate change. There is no published assessment of the funding needs in this domain, but an envelope of a few billions or a few tens of billions USD per year would already represent a huge improvement compared with the current situation. Rapidly growing urban places have a disaster vulnerability that is growing exponentially because of rapid urbanization and infrastructure shortage. Additional investments in cities could, therefore, yield particularly high benefits.

Conclusions

This note supports the view that an international scheme designed to help developing countries adapt is necessary, but that, in the near future, using a too strict definition of adaptation would not allow the funding of the most useful projects. The most efficient projects to reduce climate vulnerability, indeed, have often development-related benefits that are large enough to justify their implementation even in absence of climate change. There are not, therefore, adaptation projects in the strictest sense, but they may be the most able to reduce future impacts of climate change. These projects, in spite of their benefits, are not always implemented because of insufficient funding. An international support to adaptation should make these investments possible, thereby reducing future climate vulnerability.

The most specific projects, designed to respond exclusively to a precise change in climate, may be impossible to conceive in the very next decades, because of the large uncertainty in future climates at the local scale. In such a context, broader measures and policies designed to reduce climate vulnerability should be preferred.

Over the next decades, moreover, climate change is likely to remain limited, and most of the impacts are expected in the second half of this century. What is most needed from a climate-change perspective, therefore, is to prepare economies to cope with larger climate-change impacts over the medium to long term. Development is very efficient to do so.

Also, it is critical that climate-sensitive development investments, which are carried out today for non-climatic reasons, take into account climate change to avoid being ill-adapted and requiring retrofitting in the future. This need also supports the inclusion of development investments in our definition of adaptation investments.

In developing countries, adaptation aid can also rely on technology transfers. Debates about technology transfers for mitigation purposes should be extended, therefore, to include adaptation technologies.

As a consequence, this note promotes an international scheme that would support adaptation measures, defined in the broadest sense, i.e. as "*measures that reduce the vulnerability to climate conditions, i.e. the welfare losses potentially caused by climate or weather conditions (including current climate extreme events).*" Stricter definitions are likely to lead to "anti-selection," i.e. to the rejection of the most efficient strategies to cope with climate change.

With such a view, many development actions can be labelled as adaptation, and can be – at least partly – funded by an adaptation international scheme. An adaptation international scheme, therefore, can be viewed as an addition to traditional ODA, and will be referred to as "Adaptation-Driven ODA" or "Official Adaptation-Driven Development Fund."

The difference between this adaptation-driven development funding and normal ODA is twofold:

(i) The adaptation-driven development fund is directed in priority toward the most climate-vulnerable countries and sectors, and supports only projects that reduce the vulnerability to climate change and weather extreme events.

(ii) The adaptation-driven development fund is additional to normal ODA; it is funded through specific channels, explicitly distinct from ODA channels; and the contribution of each country can be defined by climate-related criteria (e.g., through a carbon tax or a tax on air travel).

The clear separation of funding sources and channels should ensure that the creation of this adaptation-driven development fund does not lead to a reduction in normal ODA.

Possibly, adaptation funding could also focus on specific sectors, where insufficient funding is a constraint in the present situation, and where additional investments would reduce climate vulnerability and bring immediate benefits in terms of safety, health, and sustainable development. Examples of such sectors are water (drinking, sewage, sanitation, treatment), where $50 billion USD per year are missing to reach the 2015 U.N. Goals, and disaster risk reduction, especially in urban environments.

This note also reviews the published assessments of adaptation costs. Top-down approaches suggest that adaptation costs in developing countries will lie between US$4 and 109 billions per year in the next decades, while bottom-up approaches suggests that these costs will be much lower. In addition to serious methodological problems, this difference between top-down and bottom-up assessments arises from a difference in the definition of what is adaptation, top-down approaches using a broad definition of adaptation while bottom-up approaches use a stricter definition.

The limitations of all costing methodology must be taken into account in the discussion, as it is still out of our reach to assess the cost of adaptation (and residual impacts). Flexibility must, therefore, be introduced in any adaptation scheme, to make sure that it can cope with (positive or negative) surprises in the future.

It has to be mentioned that adaptation costs are different from compensation amounts. The adaptation cost is determined from the investments needed to mitigate the loss of income; compensation is determined from the impact of climate change, i.e. from the loss of income due to climate change, including adaptation expenditures (or, in other words, from the sum of adaptation costs and residual impacts). In many situations, it would be difficult to consider only adaptation and disregard compensation, especially where adaptation is inefficient. However, making the distinction between adaptation aid and compensation perfectly clear in the scheme would make it easier to find a compromise.

The investigation of risk reduction investments in developing and developed countries shows that many risk reduction projects are not implemented, even when benefits largely exceed costs. Funding, therefore, is only one of the obstacles to climate adaptation, and investigating and overcoming other obstacles and barriers will be crucial to succeed in limiting climate change impacts.