Synergy of adaptation and mitigation strategies in the context of sustainable development: the case of Vietnam☆

Hanh H. Dang[a*], Axel Michaelowa[a], Dao D. Tuan[b]

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☆ The views expressed here are those of authors; they do not represent those of their institute, governmental office or sponsoring body

a Hamburg Institute of International Economics, Neuer Jungfenstieg 21, 20347 Hamburg, Germany
* Corresponding author
Tel: (49 40) 42834 272 – Fax: (49 40) 42834 451 – E-mail: dang.hong.hanh@hwwa.de

b National Office for Climate Change and Ozone Layer Protection, Nguyen Du street 57, Hanoi, Vietnam

Abstract

An emerging topic in current climate negotiations is the political momentum for recognising adaptation to climate change as a crucial part of a comprehensive climate policy. However, there are a number of arguments and doubts raised by politicians, negotiators and environmentalists alike with regard to the necessity of implementing adaptation in parallel with mitigation. The first aim of this article is to analyse possible contradictions and synergies between these two strategies and analyse the implications for developing countries and sustainable development targets. We then use Vietnam as a case study to demonstrate how to integrate mitigation and adaptation strategies that can provide additional benefits to the social welfare. This empirical analysis provides a basic understanding of how to address thorny questions in a nascent process of designing public climate policy in Vietnam. Lessons drawn from this research should be replicable in other developing countries having similar circumstances.

Key words: adaptation, mitigation, climate change, Vietnam, sustainable development

1. Introduction

Regardless of how effectively precautionary measures are taken by the global community to limit anthropogenic greenhouse gas (GHG) emissions, a non-negligible degree of global climate change is unavoidable due to the long life span of GHGs in the atmosphere and the inertia of the climate system (IPCC, 2001). This means that the question no longer should be framed as whether climate change impacts exist but "how severe they will be", "how soon they will occur" and "what we should do now to reduce adverse impacts in the future".

After years of being treated as a marginal option by scientists and decision makers worldwide, adaptation is currently receiving more attention as a crucial part of a comprehensive global climate policy along with mitigation (Smith, 1997; UNEP/IVM, 1998; Kates, 2000; IPCC, 2001a; Adger, 2001; Burton *et al.*, 2002; Huq, 2002). Especially since three new funds were

established at the second half of the sixth Conference of the Parties (COP6*bis*) to the United Nations Framework Convention on Climate Change (UNFCCC) in June 2001 to assist developing countries in adapting to climate change, adaptation has become a "hot" topic in research and policy arenas. Nevertheless, there has been little explicit comparison and evaluation of mitigation and adaptation strategies in order to understand whether they could be complementary or a substitute for each other, to discuss a theoretical optimum and to achieve realistic climate change strategies at national and international levels.

At the global scale, there is a growing recognition of the significant role that developing countries play in determining the success of global climate change policies (Müller, 2002). Many governments of developing countries have started to realise that they now should not discuss *whether* to implement any measures against climate change, but *how* drastic these measures should be and *how* to design integrated climate policies that can go hand in hand with national sustainable development paths to maximise "win-win" opportunities. However, climate policy sets which include both options - mitigation and adaptation - still receive little attention within the planning process of national sustainable development agendas in many developing countries. This could be due to the perception that commonalities are small. Moreover jurisdictions are different, and the costs and benefits are differentially distributed.

This article starts by discussing contradictions and interactions between the two kinds of climate strategies and their implications for developing countries and sustainable development targets. We argue that implementing and integrating mitigation and adaptation in practical decision making processes in developing countries may have some important benefits.

We then identify possible synergies and trade-offs between mitigation and adaptation strategies in specific sectors at the national scale of Vietnam. Vietnam is a low income developing country with low GHG emissions, and high vulnerability to the impacts of climate change. In recent decades, the country has been facing conflicts between environmental degradation and growing socio-economic pressures.

This empirical analysis provides a basic understanding to address thorny and fundamental questions in a nascent process of designing public climate policy in Vietnam. These major questions include: which short-term package of measures should be taken by the Vietnamese policy makers given limited resources and deep uncertainties concerning both the costs of mitigation and the degree of impacts of climate change? How will adaptation and mitigation strategies be likely to influence the future sustainable development prospects of the country

and the region? And how can these synergies be better integrated into long-term national development plans and other environmental programmes?

2. Linkages between adaptation and mitigation

Adaptation versus mitigation

To avoid "dangerous interference with the climate system" (UNFCCC, Article 2), humans can apply two primary means: mitigation (prevention) or adaptation (protection). Mitigation refers to an anthropogenic intervention to reduce the sources or enhance the sinks of GHGs. Adaptation refers to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities (IPCC, 2001a).

A huge variety of forms of adaptation exist. They can be differentiated according to numerous attributes that include, *inter alia*, purpose, time of action (e.g. before or after disasters happen), temporal and spatial scopes, form of adaptation instruments (e.g. legal, financial or technological instruments) and actors of adaptation strategies (autonomous or planned adaptation) (see IPCC, 2001a, Chapter 18 for more details).

Until recently, the primary focus in climate policy has been on the targets and time schedules to reduce GHG emissions. The architecture of the international agreements reflects this approach by setting absolute emission targets that were indicative under the UNFCCC and shall be legally binding under the Kyoto Protocol (Michaelowa, 2001).

Nevertheless, while both the UNFCCC and the Kyoto Protocol concentrate overwhelmingly on mitigation, a framework for adaptation actions was set up within these legal frameworks (Burton, 2000; Verheyen, 2003). The recognition of the need for adaptation along with mitigation is specified in Article 4.1 of the UNFCCC.

> *All Parties... shall... formulate, implement, publish and regularly update national and... regional programmes containing measures to mitigate climate change... and measures to facilitate adequate adaptation to climate change.*

The UNFCCC also contains other clauses that specifically address adaptation (Article 4.3 and Article 4.4). Under the Kyoto Protocol, Article 11 indicates the need for an improved understanding of climate change impacts, which is necessary condition for successful adaptation. Article 12 defines an Adaptation Fund generated from a levy on clean

development mechanism (CDM) projects. The fund aims at assisting the most vulnerable countries in meeting costs of adaptation. Moreover, UNDP has developed an Adaptation Policy Framework (Burton and Lim 2001).

Naturally we must ask the following questions: 1) Why has it taken such a long time for researchers and policy makers alike to pay adequate attention to adaptation? 2) Why have almost all policy makers and negotiators considered mitigation and adaptation as unrelated policy alternatives or even opposing the latter, in what Wilbanks (2002) calls the "apple or orange" dilemma?

To sketch the picture of this "apple or orange" conflict, we analyse the problem from both a political and an economic perspective.

Adaptation and mitigation represent two options to respond to climate change. They both seek to avoid the potential damages of global climate change, and they both seek to support the development of present and future generations in a sustainable manner. However, the influence and incidence of employing them as climate policy instruments are different as summarised in Table 1.

<<**Insert: Table 1** Commonalities and differences between mitigation and adaptation>>

Yet starting from the point of view of the precautionary principle, architects of international legal agreements on climate change and negotiators under these legal frameworks have a sound rationale to support mitigation as a major instrument against the challenge of rising emissions of man-made GHGs. As scientific evidence becomes ever more certain that anthropogenic GHG emissions accumulate in the atmosphere and affect the world climate system (IPCC, 2001), reducing GHG emissions must be emphasised as the first choice of actions to achieve the "ultimate objective" of the UNFCCC. This can be compared to preventing a sickness before it breaks out, not just treating it afterwards. More strongly, some researchers and analysts confirm that the precautionary principle, expanded to adaptation in the context of the UNFCCC and the Kyoto Protocol, justifies the implementation of effective and planned adaptation strategies already before climate change impacts materialise (Burton, 2000; UNEP, 2001). Indeed, "if climate change is inevitable, adaptation to its effects is also inevitable" (Smith, 1997).

There are also other reasons against considering adaptation more aggressively as a response (Burton, 2000), e.g. some argue that socio-economic development to meet human needs will have more impact on climate change through rising emissions than damages due to climate change will inflict on future socio-economic conditions, at least in the short term (UNEP, 2001).

Experience from international cooperation to solve global problems, such as stratospheric ozone depletion and infectious diseases, shows that the relative success of cooperation depends on the economics of the problem and its proposed solutions (Kaul *et al*., 1999). Theoretically, a cost-benefit analysis should be the basis for the development of a climate policy strategy.

In line with such a social optimisation analysis, Fankhauser (1998) suggests a function to estimate damages from global climate change that determines the relation between three cost elements (present value): mitigation cost (MC), adaptation cost (AC), and residual damage cost (D). To maximise social welfare, it is therefore necessary to:

minimize $MC(m) + AC(a) + D(m,a)$

(m) and (a) here are mitigation and adaptation actions, respectively. D depends negatively on the magnitude of (m) and (a).

This function and the diagram below, representing the marginal cost curves of mitigation and adaptation (figure 1), indicate that the more ambitious the targets of (m) and (a), the higher the cost of their implementation, respectively.

<<Insert: Figure 1 Marginal cost curve of mitigation and adaptation>>

A crucial element of this analysis is the choice of a social discount rate. This is controversial and leads to hugely differing recommendations concerning timing and magnitude of measures.

Obviously, investing in adaptation options means that this allocated resource will not be available to invest in mitigation actions, and vice versa. Understandably, policy makers would be under pressure to pursue only one strategy that stakeholders could benefit from and support. This may be less relevant in the case of countries that under business-as-usual would not spend funds on either option and try to get any climate-change related funding through donors. But in countries willing to spend some resources, a concentration on one strategy seems likely. Besides, research on political economics distinguishes between the output of a

mitigation measure, which can be considered a global public good with extensive possibilities for free riding, and the output of an adaptation measure, which can be viewed either as a private good or a club good, depending on the type of adaptation actions (Kaul *et al*., 1999; Kane and Shogren, 2000; Harris, 2002).

Meanwhile, climate change damages are not distributed spatially in exactly the same way as GHG emissions (UNEP Collaborating Centre on Energy and Environment, 1998). The industrialised countries, which are mostly situated in temperate climatic zones, are the largest emitters but are expected to experience relatively low damages from climate change, with some countries perhaps even gaining net benefits from moderate warming as described by Tol *et al.* (2000). Although GHG emissions in poorer countries are much lower than in richer countries, the professional consensus is that tropical and subtropical developing countries will be heavily hit by climate change even if its magnitude in terms of temperature change may be relatively small. These countries are more vulnerable to adverse impacts and lack sufficient capacity to adapt (Depledge, 2002). Moreover, some activities are more vulnerable for biophysical reasons. Tropical crops may be growing close to their limits of heat tolerance and small increases in temperature in the tropics may have more impact than similar increases in temperate latitudes[1]. So the sign and magnitude of climate change impacts and susceptibility to these impacts vary across the geographical regions (Tol *et al.*, 2000; IPCC, 2001a).

Clearly, distinct divergences in terms of national self-interests, damages and benefits in relation to the global climate change *per se*, as well as response policies, imply that incentives for, and the willingness of, countries to implement mitigation and adaptation actions are asymmetrical. Many industrialised countries with a high mitigation burden due to high per capita emissions are likely to have much lower adaptation costs. From a purely national standpoint, damages in other countries do not matter as long as they do not lead to spillover effects, such as streams of climate refugees and general political instability.

In that sense, numerous politicians and negotiators under the UNFCCC fear that increasing interest in adaptation may lead the world community to deviate from the long-term target of "stabilisation of greenhouse gas concentrations in the atmosphere" as referred to by the UNFCCC (Article 2) and therefore go against the precautionary principle agreed by all Parties to the UNFCCC.

The US withdrawal from the Kyoto Protocol in 2001 fuels these fears as it can be understood exactly in the sense outlined above: the US can adapt cheaply, but mitigation is too expensive.

1 We thank an anonymous referee for making this point.

This interpretation is reinforced by the Bush Administration's "US Climate Action Report 2002" which recommended shifting the focus from reducing emission of GHGs to adapting to the impacts of climate change (U.S. EPA, 2002). Many environmentalists, especially representatives from non-governmental organisations, strongly criticise this statement. Their concern may be that recognising that adaptation is as significant as mitigation would imply support for this anti-Kyoto Protocol opinion, and hence delay the global effort to reduce GHG emissions. Kates (2000) classifies the fear that increasing adaptation may weaken the social effort to undertake GHG emissions as "limitationist" bias. He also defines another bias, which leads to paying too little attention to adaptation as "adaptationist" or "wait and see" as per Smith's definition (1997). "Adaptationists" see no need to take steps now to adapt to the potential impacts of climate change, simply trusting either natural selection or market forces to encourage autonomous adaptation. The adaptationist approach also leaves future generations, who are expected to have more income and more sophisticated technologies, to cope with future climate change.

In summary, mitigation and adaptation are currently perceived to be mutually exclusive at worst, or parallel strategies at best. This is reinforced by the fact that the structure of the UNFCCC reporting guidelines for national communications include a separate section on adaptation, rather than requiring Parties to report adaptation strategies under "policies and measures". Even countries that, at first glance, would have a large stake in adaptation, such as the Netherlands, make just a passing reference to it (Netherlands, 2001) even if this may not reflect the true state of awareness in the country.

Linkages between mitigation and adaptation

Several studies reflect the linkage between mitigation and adaptation options under the climate change regime as a "cause and effect" interaction. While some uncertainties remain, atmospheric scientists widely agree that the projected rate and magnitude of climatic changes can be lessened by reducing GHG emissions (IPCC, 2001a). This means that adaptation costs and challenges can also be lessened by mitigating climate change (IPCC, 2001b). In other words, the need for, and scope of, future adaptation are inextricably related to the current level of mitigation of GHG emissions (AfDB *et al*, 2002). Besides, adaptation has another special link to mitigation through the Kyoto Protocol adaptation fund (Article 12). As a result, the more effective the CDM is, and the more it is used, the greater the funds that can be expected for adaptation assistance (Burton, 2000).

From the perspective of adaptation, there may be direct feedbacks with mitigation efforts (Adger, 2001), which can themselves serve as mitigation measures (Wheaton and Maciver, 1999). For example, some adaptation policies in the land use and forestry sectors may have the potential to avoid methane emissions and enhance CO_2 sequestration. It is important to check the extent of these synergies. Also, watershed management policy to reduce flooding often includes reforestation, which sequesters carbon. However, the tree species preferred for carbon sequestration may not be the preferred species for watershed management and biodiversity protection, so while there is some synergy, it is not complete.

Moreover, feedbacks between adaptation and mitigation may not always be positive. Adaptation responses to the adverse impacts of climate change on human health or on land-use may negatively affect national efforts to reduce GHG emissions (Michaelowa, 2001). At a local or national scale, the reverse may also be the case, that is, mitigation projects may have ancillary adaptation benefits.

The central question is now whether mitigation and adaptation strategies are to be considered as separate instruments, or whether appropriate integrated strategies should be formulated that exploit synergies and address trade-offs.

Acknowledging the cause and effect relationship between mitigation and adaptation, a "clairvoyant" formulation of strategies that exploit synergies and address trade-offs can make climate policies more responsive, comprehensive and efficient. While one may doubt that an optimal strategy with an appropriate mix of adaptation and mitigation responses can be operationalized in practice due to the inevitable conflict of interests, this objection also applies to any policy that has globally diverging costs and benefits and implies negotiations between sovereign states.

Integrating mitigation and adaptation within the framework of the UNFCCC

At present, there are only a few ongoing studies trying to identify the interaction between mitigation and adaptation on a country-specific level (namely, the US (Wilbanks, 2002) and Australia (Government of Australia, 2001)). So far, no country has explicitly mentioned and/or addressed the potential for combining mitigation and adaptation in its national climate change strategy.

Integrating mitigation and adaptation within the framework of the UNFCCC to design more socially acceptable and economically feasible climate policies has been mentioned by a number of researchers (Wheaton and Maciver, 1999; Burton, 2000; Kane and Shogren, 2000; Adger, 2001; Michaelowa, 2001; IPCC, 2001a; UNEP, 2001; Smith, 2002, Wilbanks, 2002).

Kane and Shogren (2000) developed an elaborate model that treats climate change as endogenous risk and assesses an optimal mix of mitigation and adaptation. The model examines in theory how a change in climate risk affects the nation's mix of adaptation and mitigation. The result shows that impacts of changing risk on the levels and proportions of the two measures in a nation's response will depend directly on the risk impacts on the marginal productivity of each measure and indirectly on whether mitigation and adaptation complement each other or substitute each other. However, this research does not address systematically how far both options are complements or substitutes.

By applying public choice theory and a simple framework to determine the share of mitigation and adaptation in an optimum mix, Michaelowa (2001) draws a similar conclusion. That is, proportional sharing of each policy in an optimal decision depends on the relative slope of the marginal cost curve of each policy (see Figure 1).

One major challenge is to strike a balance between social benefits and costs in the context of equity concerns and real-world constraints, given the difference in time scales, spatial scales and institutional actors of the two strategies and deep uncertainty as regards to climate science and regional climate impacts. This challenge is, however, also relevant for each strategy on its own. Another challenge is to find common and comparable metrics and tools for economic analysis.

3. Implications of integrating mitigation and adaptation for developing countries and sustainable development

A globally optimal solution to excessive GHG emissions – one that combines mitigation and adaptation – requires the global cooperation and participation of developing countries (UNEP Collaborating Centre on Energy and Environment, 1998). As most developing countries have a limited share of cumulated emissions in the atmosphere and their governments are faced with profound struggles for survival, it is individually rational for them not to take climate change into account when making development decisions. Fortunately, the decision taken at COP 6 *bis* on a 2% "adaptation levy" on the CDM, and promised financing of National Adaptation Plan of Actions (NAPAs) for the least developed country (LDC) parties, has drawn attention to the climate change agenda in developing countries looking for adaptation assistance. However, except for national communications, in which adaptation and mitigation are mentioned simultaneously even though adaptation is often not treated as intensively as

mitigation, to date most governmental officials and analysts still perceive mitigation and adaptation as separate or pure substitutes to each other. Thus, financial and natural resources, as well as human capacity, must be spent separately to implement two different policies. However, so far, apart from a commitment to provide a minimum of US$410 million per year for climate change activities made by the EU, Canada, Iceland, New Zealand, Norway and Switzerland, only the government of Canada has announced a specific grant (US$6 million) to jump-start the LDC fund (Huq, 2002), although this has been supplemented by voluntary contributions from several other countries. Clearly, external assistance will not be sufficient for developing countries to cope with social and economic shocks caused by current extreme events and potential adverse impacts of future climate change.

Moreover, if decision makers tend to stay in a vicious "apple or orange" circle, they may act without information about comparisons between the two options (Smith, 2002). This approach would have unfavourable implications on national efforts to avoid GHG emissions[2] and adapt to severe potential impacts of climate change.

Within the context of limited resources, a set of national climate policy actions that takes into account the synergies and trade-offs between mitigation and adaptation will have important benefits for developing countries. Properly organised CDM projects will bring an additional inflow of capital to host countries (Burton, 2000). Integrating adaptation options in these projects would maximise the utility of this inflow and contribute to an increase of domestic capacity to cope with the risks associated with climate change. Such an integrated policy will enhance the chance of survival of projects with a long lifetime (IPCC, 2001b).

Given the breadth of these concepts, we make the following conclusions for this section:

- A comprehensive, minimum cost global climate policy strategy should not tackle mitigation and adaptation measures in isolation to each another.
- Integrated strategies should promote sustainable management of resources and the environment at the national, as well as global, scale.
- Integrated strategies should facilitate a more active role for developing countries in the UNFCCC and Kyoto Protocol process.

There is still a dramatic disconnect between academic arguments and reality. We therefore use Vietnam as a case study to demonstrate how such integration may be approached.

2 We agree and borrow an "avoided emissions" concept introduced by Environnement et Développement du Tiers Monde (ENDA-TM) that means in the beginning of the climate change process, developing countries

4. Potential synergies and trade-offs between mitigation and adaptation strategies in Vietnam

Vietnam is located in South East Asia. It has around 3,260 km of coastline and more than 3,000 inshore and offshore islands. The Vietnamese climate is dominated by the tropical monsoon with high heat and humidity, and is one of the most disaster-prone countries in the world, especially concerning water-related disasters (UNDP Vietnam, 2002). On average, between 4 and 6 typhoons reach Vietnam each year (Government of Vietnam, 2002a). The most intensively areas hit by water-related disasters are the deltas of the Red and Mekong rivers – two major agricultural regions. Large areas of these deltas are less than one metre above mean sea level; some areas are even below sea level (Granich *et al.*, 1993).

In 2001, Vietnam had a population of about 80 million, of whom 40 million live below the national poverty line (World Bank, 2002). Currently, over 70% of the population live in rural and low-lying coastal areas that are susceptible to water-related natural disasters (UNDP Vietnam, 2002). Vietnam has undergone rapid economic growth and industrialisation in the past decades. The average annual GDP growth rate was 7.5% between 1991 and 2000, and Gross Domestic Product (GDP) per capita was $400 in real terms and $2100 in purchasing power parity terms in 2001 (World Bank, 2002). Vietnam is primarily a rice-based agricultural economy, with agriculture representing 24.3% of total GDP in 2001 (Government of Vietnam, 2002a).

The national GHG inventory for 1994 shows that total GHG emissions were 103.8 million tonnes of CO_2-equivalent. The main emission source sectors were agriculture (52.5% of total), forestry (19.4%) and energy (24.7%)[3]. The energy sector is expected to grow more rapidly than the other sectors and become the largest source of emissions in the future (Government of Vietnam, 2002a).

After ratifying the UNFCCC (November 1994), Vietnam carried out national research and participated in several regional studies aimed at providing a systematic overview of the climate change issue, its potential impacts on the country and the country's response. Most recently, Vietnam submitted its first National Communication (VINC) in October 2002

have no commitments to reduce emissions but to avoid increases of them due to the development process in the first place.

3 The emission sectors under this inventory were classified according to the IPCC guidance version 1996

(Government of Vietnam, 2002a) and its "National Strategy Study on CDM" (Government of Vietnam, 2003). Until now, almost all studies have been oriented towards the country's potential to reduce GHG emissions. To prepare the VINC, simple scenarios on climate change and its impacts on Vietnam were simulated based on the CSIRO model (CSIRO, 2002). In addition, several studies on assessment impacts of climate change in coastal areas have been carried out in Vietnam, but no countrywide study to date has applied inter-disciplinary methods to assess climate impacts and adaptation options in the most vulnerable socio-economic sectors and ecosystems.

The major direct impacts and adaptation options for selected natural and socio-economic resources in Vietnam are summarised in Table 2. These direct impacts lead to more serious consequences for the development of the country since they cause significant losses both economically and in terms of human casualties.

<<**Insert: Table 2** Major direct impacts and adaptation options for selected natural and socio-economic resources in Vietnam>>

We emphasise that there are two main concepts to integrate mitigation and adaptation strategies at a national scale.

Firstly, it is beyond question that coping with the long-term problem of climate change calls for decisions now. Taking a national decision that includes a rational balance between mitigation and adaptation and that will bring most benefit for the country requires a comprehensive study based not only on a firm socio-economic database, but also on scientific assessment of vulnerability to long-term climate change in major natural and socio-economic sectors. Otherwise, the costs of planned adaptation cannot be assessed with a sufficient degree of robustness (UNEP/IVM, 1998). Given uncertainties concerning local and regional climate change impacts and the estimation of planned adaptation, such a comprehensive study remains a challenge and needs constant updating. It would be a necessary condition for attracting donor funds for both mitigation and adaptation measures.

Secondly, every decision taken today has an influence on inter-generational equity. To reconcile the benefits between different generations, it is necessary to identify overlaps and interactions between mitigation and adaptation options when making short- and medium-term decisions. Here the question of discounting of future impacts is of critical importance. A low rate leads to early action centring on immediate adaptation, while a high rate shifts activities to the future.

Mitigation options and "ancillary benefits of adaptation"

Mitigation options in Vietnam have been assessed in the energy, forestry and agricultural sectors. A multi-criteria analysis (MCA) technique is applied to prioritise mitigation options in Vietnam (Government of Vietnam, 2002a, 2003); the results are illustrated in Figure 2 using two main criteria:

- Commercial availability: potential to attract international investors (demand side) and capacity to provide certified emission reductions (supply side) as part of a CDM project.
- Sustainable development: capacity of a project to contribute to sustainable development in Vietnam.

For simplicity, agriculture and forestry are the foci of the analysis since agriculture is the largest emission source in the country, thus providing a high opportunity for mitigation. Tropical forest covers around 28% of Vietnam's total area and is an important carbon sink. However, three mitigation options in the energy sector are also evaluated so that an inter-sectoral comparison is possible.

<<**Insert: Figure 3** Priority CDM projects in Vietnam selected in terms of commercial attractiveness and sustainable development criteria>>

For the purpose of our research, an "adaptation benefits of mitigation" criterion is developed to reflect the direct impacts of mitigation options on the country's adaptation capacity. Figure 3 illustrates priority CDM projects in Vietnam according to "adaptation benefits of mitigation" and sustainable development criteria.

<<Insert: Figure 3 Priority mitigation options in Vietnam selected in terms of adaptation benefits and sustainable development criteria>>

Including "adaptation benefits of mitigation" as one criterion in the set of multi-criteria analysis provides more essential inputs to potential CDM projects in Vietnam as reflected in Table 3.

<<Insert: Table 3 Selected potential mitigation options in Vietnam by MCA>>

Table 3 demonstrates that feasible CDM options exist in each emission sector with secondary benefits to promote resilience to climate change, hence these options can facilitate anticipatory adaptation. From the perspective of social welfare optimisation, such options would help maximise national welfare due to increased benefits derived from the implementation of projects.

Adaptation options and avoided GHG potential

Smith (1997) suggests some basic criteria to identify priority adaptation options. We apply two of those criteria:

- Irreversible or catastrophic impacts: anticipatory strategies need to be implemented to adapt to climate change impacts that are irreversible or catastrophic.
- Long time-frame decision: policy makers have to consider the lifetime of adaptive measures since many decisions can have ramifications over decades or centuries.

To examine the potential influence of adaptation options on national GHG emissions, we develop an "avoided GHG potential" criterion as a component of this set of criteria.

We choose the agriculture and water sectors as the focus of a detailed analysis because of their vital role in the national economy, national poverty reduction programme and sustainable development path. Moreover, agriculture in Vietnam is inherently vulnerable to climate conditions.

The results of the analysis of anticipatory adaptive options in water management and agriculture are summarised in Table 4 below.

<<**Insert: Table 4** Screening matrix for adaptation options in water resource and agriculture in Vietnam>>

These results indicate that sectoral adaptation strategies can influence abatement positively or negatively. Actually, the quantified changes in GHG emissions arising from the implementation of adaptation strategies depend on many factors, i.e. climatic stimuli, traditional cultivation techniques, economic factors etc. Thus, there is a need for more specific research to answer these questions. Although our examination concentrated on two sectors, the analysis clearly shows the interaction between sectoral adaptation and mitigation options.

From the above analyses, an appropriate activity to improve the operation and quality of the irrigation system would provide both mitigation and adaptation benefits. Investment in

irrigation is also a government priority with a state budget for irrigation development of around US$1 billion for the period 1996-2000. The annual irrigated paddy area accounts for up to 6.8 million ha or 89.9% of total cultivated area (Ba, 2001). Of this, approximately 5.5 million ha would be cultivated under water management to reduce methane emissions with the aim of increasing rice yield (Asian Development Bank, Global Environment Facility, United Nations Development Programme, 1998; Government of Vietnam, 2002a). Many studies in Vietnam suggest that an improved irrigation system can increase rice productivity by 16-35% (Tiep, 2001), and hence contribute to rural poverty alleviation, which is also the first priority task in the national sustainable development strategy. A balanced and appropriate policy in this sector would not only be a "win-win" climate option but also a "no-regret" solution that can produce social benefits today, regardless of climate change.

What can we learn for developing a climate policy framework in Vietnam?

Despite its priority to achieve accelerated economic growth, the government acknowledges that controlling and reducing the consequences of disasters are also key priorities, and it has developed an action plan for disaster mitigation (Government of Vietnam, 2001) as well as an Agenda 21 (Government of Vietnam, 2002b). Unfortunately, the Action Plan was designed to address short-term climate extremes rather than to respond to future climate change, including variability and extreme events that can harm the long-term sustainable development of the country. Given the above potential synergies between mitigation, adaptation and national development plans, what kind of policy recommendations can we propose to articulate mitigation and adaptation into a coherent development policy in Vietnam?

In the short- and medium- term, developing a proper integrating framework should be the first priority. To embark on this endeavour, quantification of the synergies is key and we have only been able to give some qualitative indications. This framework can be elaborated by a national climate change action plan that includes adaptation and mitigation strategies, and also emphasises interconnections between the two response options as well as the potential effects from implementing these strategies on key ecosystems, resources and economic sectors. In the short-term, there are also some objections against "low hanging fruit" CDM projects, so maximising and exploiting adaptation benefits from such projects will have positive influences on the decision making process.

5. Conclusion

Given the fundamental distinctions between mitigation and adaptation options from different perspectives, trying to simply amalgamate the two options and achieve double benefits from

each action to reduce GHG emissions or adapt to climate change is not realistic at either the national or global scales. Moreover, a "forced marriage" strategy may be counterproductive as it could depress the global effort to pursue the long-term objective of the UNFCCC in case the integration fails. This paper rather asserts that adaptation is not necessarily opposed to mitigation, or a substitute for it, as many adaptation options are also pathways towards effective and long-term mitigation and, in turn, several mitigation options can facilitate planned adaptation as well. If a comprehensive national climate policy could strike a rational balance between mitigation and adaptation instruments that maximises the potential synergies between them, climate policies could become socially and economically efficient and may offer greater opportunities for countries to achieve sustainable development targets despite the large scientific uncertainty. This is especially important given the limited financial and human resources in developing countries.

In addition, a mainstreaming approach to integrate mitigation and adaptation policies into national development plans is emerging in the international climate policy negotiations. It is increasingly acknowledged that the ability to adapt is linked to the ability to mitigate and vice versa, given the long-term impacts of climate policies. This mainstreaming concept will not be a versatile and long-lasting approach if adaptation and mitigation are approached separately from one other in developing climate change strategies.

The qualitative analysis of this paper shows that several project categories with mitigation and adaptation synergies could offer tangible economic and social benefits. However, measuring these benefits and defining the optimal mix of both mitigation and adaptation requires further in-depth study at both the national and global levels, looking at specific circumstances and different time scales.

Lessons drawn from this research on how to design a harmonious and realistic strategy to combat climate change that combines both mitigation and adaptation at the national level could be replicable in other developing countries with similar circumstances. This, however, may be easier for some project categories than for others.

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Tables and figures

	Mitigation	Adaptation
Common target (final)	Sustainable development	Sustainable development
Distinct characters	Proactive action, long term reduction of climate change impacts	Reactive action, iterative depending on the real impacts of climate change Proactive if based on projected impacts
Temporal effect	Benefits to later generations	Benefits can more or less be appropriated by those bearing costs
Geographic effect	Global benefits, but varying across regions	Primarily local benefits
Co-operation degree required	Global	National, regional
Sectoral effect	Focus on emissions from fossil fuels	Very heterogeneous with some stress on agriculture
Relation to uncertainty	Setting of emission targets has to be adjusted regularly to take into account new projections	Reactive adaptation can wait until more concrete evidence of climate impacts is available. Successful proactive adaptation has difficulties to justify itself as the "baseline" impacts are unknown
Equity	Free-riding problem, especially motivated with countries less vulnerable to climate change	Unfair, the 'victims' are not always responsible for causing climate change
Secondary benefit	Some options have high local secondary benefits (e.g. reduce local air-pollutants). Some options may even directly be financially viable. Technology transfer	Some options are beneficial in the absence of climate change – "win-win" option Technology transfer

Table 1 Commonalities and differences between mitigation and adaptation

Resource	Potential impact	Adaptation option
Water resource	Changed water availability and quality Changed annual run-off Increased frequency and extreme of floods and inundation	Construct and improve irrigation and drainage system Improve sea dyke systems Promote hydropower development
Agriculture	Reduced arable area Changed crop yields Potential threat to national food security Facilitated pests development	Enhance irrigation system for agriculture Further investigate the country agroclimatology Develop flexible crop patterns
Forestry	Changed forest cover areas	Enhance afforestation [using native species etc] Protect natural forests
Coastal area	Accelerated erosion along the coasts and in river mouths Reduced wetland areas Increased salinization	Protect and develop wetland/mangrove forestry Develop local and nation-wide strategies to deal with sea level rise and extreme events
Human health	Living environment Increasing vector-borne diseases	Develop national plan to control vector-borne diseases Improve medical service quality Promote public awareness
Energy and transportation	Increase in cooling demand Changes in hydropower output Damage of existing infrastructures (power plants and distribution infrastructure, ports, transportation)	Improve energy efficiency Take into account climate change factors in planning infrastructure development Upgrade infrastructure in vulnerable areas

Table 2 Major direct impacts and adaptation options for selected natural and socio-economic resources in Vietnam

Mitigation option	Emission reduction potential (mill. t CO_2 equivalent)	Commercial attractiveness	Sustainable development	Adaptation benefits
A1: Water management for reducing methane emissions from rice fields	105.0	Low	High	Positive
A2: Food processing for animal husbandry	8.0	Low	High	Neutral
A3: Utilisation of biogas	27.3	Low	Low	Neutral
F1:Protection of forest	1302.6[4]	Low	High	Positive
F2: Combination of forest nursing and delineation for regeneration	372.6[4]	Low	High	Positive
E1: Replacing coal boilers fired in industry	10.2	High	High	Neutral
E5: Developing solar energy	26.1	Low	Low	Neutral Positive as resilience is strengthened
E13: Developing small scale hydropower	342.1	High	High	Positive

Table 3 Selected potential mitigation options in Vietnam selected by MCA

Adaptation option	Irreversible/catastrophic	Long term	Avoided GHG potential
Water management			
Construct and improve irrigation and drainage system	x	x	Positive to negative (Positive in case it leads to reduce energy consumption) + Drainage systems can be used for hydropower generation - Energy use for pumping
Improve sea dyke systems	x	x	Negative (may reduce biomass from wetland areas and increase energy demand due to pumping)
Promote hydropower development		x	Positive
Agriculture			
Expansion of irrigation system	x	x	Positive to negative + Lower energy intensity - Higher methane emissions
Further investigate the country agroclimatology	x	x	Neutral
Use of more robust seeds for forests			Positive
Develop flexible crop patterns		x	Negative to positive (depends on fertilizer input and energy intensity of cropping)

Table 4 Screening matrix for adaptation options in water resource and agriculture in Vietnam

4 For mitigation options in forestry sector, these number means also the potential to enhance absorption sinks

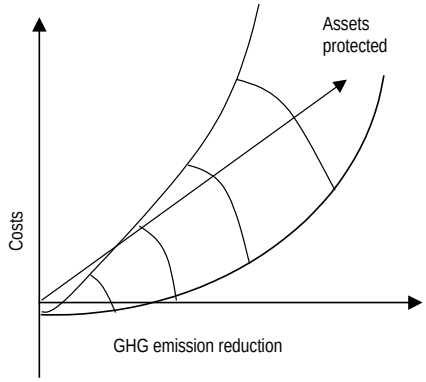
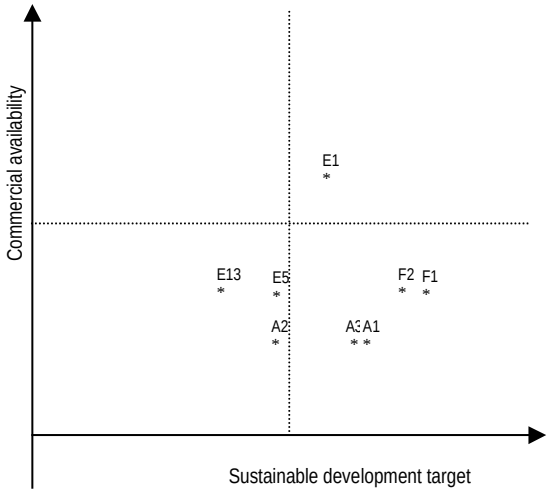


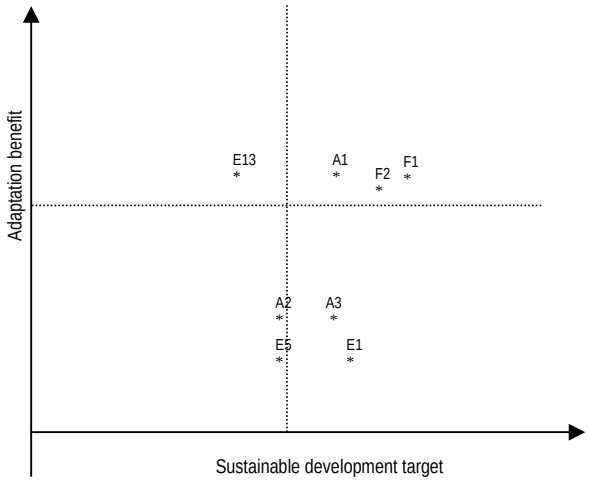
Figure 1 Marginal cost curve of mitigation and adaptation



Source: Government of Vietnam (2002a, 2003)

(Project descriptions see Table 3)

Figure 2 Priority CDM projects in Vietnam selected in terms of commercial attractiveness and sustainable development criteria



(Project descriptions see Table 3)

Figure 3 Priority mitigation options in Vietnam selected in terms of adaptation benefits and sustainable development criteria