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Assessing the Environmental Co-Benefits of Climate Change Actions

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1. Introduction

The draft 2010 World Bank Environment Strategy is built on three pillars: leveraging natural resources for growth and poverty reduction; managing the environmental risks to growth and development; and transforming growth paths. As part of its exploration of these three pillars, the Strategy considers the question of environmental co-benefits of climate change actions[2]. In particular, it poses the question of potential trade-offs between actions to address climate change and other local and regional environmental priorities, and considers how to maximize co-benefits arising from climate action.

Climate change has for the first time raised basic environmental questions to the highest levels of national government, including presidents and finance ministers. Flows of climate finance could be substantial, on the order of ODA as a share of high income country GNI, and the potential for environmental co-benefits from this finance is correspondingly large. The primary objective of this background paper is to assess the potential for climate change mitigation and adaptation actions to provide environmental co-benefits, particularly in the quality of environmental media, flow of ecosystem services, and maintenance of biodiversity. To accomplish this, the paper is organized in five sections:

1. Provision of an organizing framework to identify and classify potential co-benefits;
2. Summary of the external literature on co-benefits;
3. Review of examples from the World Bank portfolio;
4. Initial thoughts on creation of enabling conditions for co-benefit provision, and
5. Review of implications for the Environment Strategy.

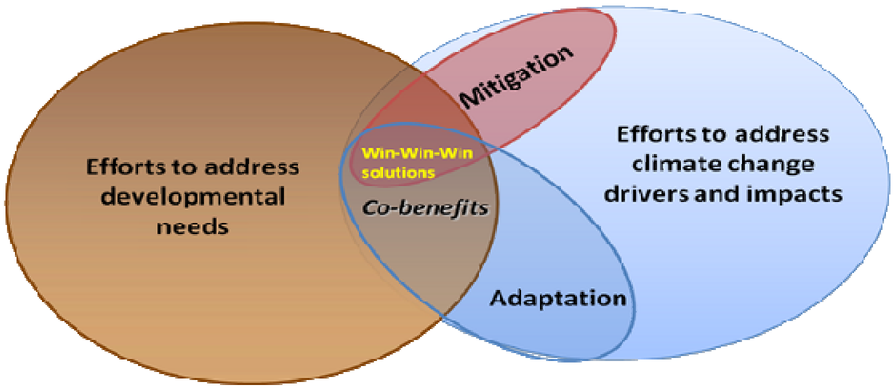
In doing so, it explicitly addresses two of the Strategy's three pillars: leveraging climate change interventions and financing to better manage natural resources and deliver growth and poverty reduction; and transforming growth paths by factoring environmental co-benefits into the equation. It indirectly addresses the third pillar of managing environmental risks, particularly in the case of adaptation to climate change, by viewing risk management through a co-benefits lens..

[2] In this paper co-benefits are defined as the benefits for the local environment as a result of (mitigation/adaptation) actions that are targeted at addressing global climate change.

2. Organizing Framework

The potential for environmental co-benefits lies at the intersection of development and climate change actions (Fig. 1).

Figure 1: Identifying environmental co-benefits



A highest priority should be 'win-win-win' solutions which are robust under a range of future climate scenarios and which create environmental benefits while simultaneously contributing to development, adaptation, and mitigation.

For example, in drought-prone areas, improved soil management practices increase fertility and soil quality, and enhance adaptation to drought by improving soil water content and resource conservation. In addition, soil and water management enhance soil carbon sequestration by returning more organic matter residues to soil, and help reduce emissions from land use, land use change and intensive agriculture practices. In turn, these actions can play an important role in the voluntary carbon markets by promoting creation of large carbon sinks and stocks.

Another win-win-win example is reduction of black carbon emissions from biomass cookstoves and dirty diesel vehicles. Because black carbon particles are associated both with local and regional warming and health impacts, there are important benefits associated with reducing their emissions, ranging from reduction in glacier melt and pressure on local natural resources to improved vehicle fuel efficiency.

In some instances the co-benefits of climate actions for the local environment are not clear and immediate, and there may be trade-offs or co-costs to be taken into account. Tables 1 and 2 provide indicative examples of climate mitigation and adaptation actions, along with their potential co-benefits or co-costs.

Table 1: Mitigation actions and environmental co-benefits (or costs)

Mitigation action	**Environmental Co-benefit or cost**
Electricity generation - low carbon fuels - carbon capture and storage (CCS) - solar, hydro, geothermal	Improved ambient air quality Solar technologies have potential costs linked to large land footprints
Other combustion (household, industrial) - low carbon fuels - CCS (for major emitters)	Improved ambient and indoor air quality
Transport - low carbon fuels - modal switch - fuel efficient vehicles and transport operations	Improved ambient air quality, reduced pressure on land, reduced congestion Switching from gasoline to diesel may increase particulate matter emissions
Development of alternative energy sources - biofuels	Potential costs, e.g. natural forest clearance or pressure on / degradation of agricultural land
Reducing deforestation	Conserving environmental services and biodiversity
Sequestering soil carbon - maintaining land cover	Potential improvements to soil fertility, reductions in soil degradation, improved water infiltration
Reducing black carbon emissions - improved cookstoves - clean diesel	Improved indoor air, reduced pressure on local biomass, Improves ambient air quality
Reducing methane emissions - flaring and leakage - landfill - water pollution control	Improved water quality Improved ambient air quality Reduced odor
Reduction nitrous oxide (N_2O) emissions - fertilizer application, fertilizer material	Reduced fertilizer runoff, protection of the ozone layer, reduced air pollution

Table 2: Adaptation actions and environmental co-benefits (or costs)

Adaptation action	**Co-benefit or cost**
Increasing buffering capacity, especially for water - dams - natural buffers Expanded protected areas for species and biodiversity protection	Dams have potential environmental costs (as well as issues with methane generation), while natural buffers like forests, mangroves and wetlands become more valuable
Siting of dwellings and infrastructure - dwellings - other infrastructure	Siting decisions may preserve ecosystems and the services they provide
Protection - sea walls, levees, barrages - human health, esp. water, sanitation, vectors	Barrages may have environmental costs. Control of disease vectors may provide benefits or costs.
New technology - crops, and crop diversity - water use efficiency - weather monitoring - land cover monitoring	Greater crop diversity will conserve biodiversity. Water use efficiency will protect ecological flows. Land cover monitoring will assist with environmental conservation.
New techniques - agriculture – vegetation cover - agriculture – soil management - landscape-scale management - ecosystem management, incl. for fisheries	Better land and vegetation management will have environmental benefits. Landscape-scale and ecosystem management will assist with protecting ecosystems and their services.

The framing of the co-benefit and co-cost issues represents a first step towards staff guidance on identification and possible integration of co-benefits into project design. As Tables 1 and 2 show, the linkages between climate actions and environmental co-benefits are well established for certain actions, such as reduced health impacts of local air pollution arising out of mitigation actions, and less well established for others.

Designing good projects to deal with climate change and achieve co-benefits will need more than co-benefit identification. It will also require good valuation approaches which are not routinely employed in standard project economic analysis, significantly deepened knowledge of the inter-linkages between climate actions and local environmental co-benefits, and improved quantitative methods for assessing co-benefits.

The economics of co-benefits and co-costs

From an economic perspective, co-benefits are outcomes of climate change actions that increase the measured flow of total benefits and thus the measured benefit/cost ratio of these actions. In climate change related projects, which are not always the lowest cost interventions, this is often the case.

For a solar thermal generation project, for instance, if the alternative is a coal-fired power plant, then the value of emissions reduction (SOx, NOx, particulates) associated with not building the coal plant becomes a benefit. The present value of direct project benefits plus co-benefits, minus project costs, determines the net economic benefits from the project. Climate finance is also an element. While the client country may not gain value directly from CO_2 emissions reductions (because the country does not have a binding emissions cap, for example), the carbon offset markets will value "additional" reductions, and selling a stream of carbon credits would therefore become part of the project benefits. If the sum of the value of co-benefits and carbon credits is high enough, the net benefits of the solar project may exceed those of the coal project, at which point it becomes the preferred project for the client. If the net benefits of the solar project are still not high enough when co-benefits and carbon credits are taken into account, then a subsidy provided by climate finance instruments such as the Climate Investment Funds (CIF) may be required before the client is willing to invest in the project.

Similar logic applies to actions such as black carbon emissions reduction. A project to provide more efficient cooking stoves or access to cleaner fuels ensures climate, health and natural resource benefits, all of which would be valued in making the decision to invest in the project. Here there may be few or no carbon market benefits if only direct CO2 emissions are being traded, but there may still be a need for a further climate finance subsidy to make the project viable.

The economic analysis of adaptation projects is more complex.. Increased risk of storm surges arises for the client country, then a specific adaptation project, such as planting mangroves, may be required. To the extent that the mangrove forest provides co-benefits to local fisheries (for example), these should appear as benefits in the economic analysis of the project. Here there is another potential interaction with climate finance, in this instance finance that is specifically targeted to assisting developing countries to adapt to a changing climate. While adaptation finance could be provided for mangrove cultivation, the amount of finance needed would (in principle) be net of the co-benefits - given the local nature of the co-benefits and the assumption above about targeting of the adaptation finance. Another example would be making infrastructure such as roads more climate-resilient. Assuming that building roads differently is more costly, the incremental costs of increasing climate resilience would become eligible for adaptation finance. Again, however, if there are co-benefits such as reduced vehicle maintenance associated with higher quality roads, then (in principle) the adaptation finance provided would be net of these co-benefits. Upgrading roads to become climate resilience also offers the potential of reducing traffic related emissions – with local and global benefits - for a small incremental cost.

The same general principles apply to climate projects with co-costs, but the signs are reversed. Co-costs drive up the cost base of the climate project and therefore reduce the net economic benefits. Carbon markets could still be interested in buying carbon credits, but while the carbon credits stream becomes a part of project benefits, the increased cost base may make the net benefit from selling the carbon credits less attractive.

The provision of co-benefits from climate actions may also be central to whether governments deal with climate change by transforming how they develop or by making incremental changes to the development paradigm. It is certainly possible that transformation is unavoidable – for example, high population numbers and scarcity of land in many developing country cities may make high use of private vehicles for urban transport untenable, for reasons both of congestion and pollution. But a broader conception of co-benefits could also drive transformation – for example, designing greener, more livable cities could substantially increase the quality of life for urban dwellers in developing countries, and attract more investment and businesses to the city – thus making it economically more vibrant.

These considerations suggest that the issue of valuing and integrating co-benefits or co-costs is likely to be complex, since those activities could make a large difference in what projects are undertaken, how they are implemented, and where the needed resources come from. But they do not override the fundamental economic principles involved – co-benefits can make climate investments more attractive, just as co-costs can make them less attractive.

Finally, placing economic values on the co-benefits or co-costs of climate change actions ultimately depends upon valuing the changes in human well-being linked to environmental change. Health outcomes are particularly important in this regard, as will be highlighted in the next section.

2. Messages from the Literature

Review of the literature on the environmental co-benefits of climate change policies and actions shows that the sectors with significant co-benefits are energy, transport, agriculture, forestry, ecosystems and biodiversity, and water. In the review, three overarching messages emerge.

First, it becomes clear that identification of mitigation co-benefits is relatively straightforward as compared to adaptation, given the established linkages between local emissions and human health. Second, particularly in the agriculture, forestry, and natural resource management (NRM) sectors, there is a fine line between an action to adapt to climate threats and a development practice that promotes conservation and quality of environmental services; the underlying assumption is that any action that enhances environmental quality and /or provision of ecosystem services (e.g. increased water availability, biodiversity conservation, soil carbon sequestration) will also enhance local climate resilience to future climate trends. Third, it is not all about co-benefits; in nearly all relevant sectors, there are often co-costs generated by adverse environmental impacts that cannot be overlooked.

The messages from the literature are summarized below by sector and presented comprehensively in Annex 1.

Energy: Energy sector interventions that generate environmental co-benefits, particularly reduced air pollution and improved health, are improvement of energy efficiency of plants, fuel switching, and renewable energy uptake.. Quantitative information on these environmental co-benefits remains primarily limited to health effects in developed countries, with many co-effects not quantified due to a lack of information/data. Studies by Swart et al., (2003), Beg, (2002) and Hagen et al., (2005) demonstrate air quality improvements and health benefits from improving energy efficiency of power plants, fuel switching to nuclear energy and renewable energy sources. Benefits – in terms if health - from avoidance of air pollution control costs as a result of energy sector interventions have been estimated by various authors, mostly in Europe and United States; Syri et al. (2001), van Harmelen et al. (2002), van Vuuren et al. (2006), EIA (1998). Analysis of co-benefits from development of new energy technologies and renewables have mostly concentrated on economic benefits like creation of employment, cost savings and development of industries.

Agriculture: Policies and measures to reduce greenhouse gas (GHG) emissions from agriculture and adapt agricultural systems to climate change have environmental co-benefits that are predominantly positive, but some trade-offs exist (DeFries *et al.*, 2004; Viner *et al.*, 2006) above certain levels or intensities of implementation. Climate policies in the agricultural sector that have significant co-benefits/costs include soil carbon sequestration, tillage and other agronomic practices for mitigation and adaptation, production of bio-energy crops, sustainable agricultural practices and organic agriculture and land retirement.

Carbon conserving practices are found to sustain or enhance future fertility, productivity and resilience of soil resources (Lal, 2004a; Cerri *et al.*, 2004; Freibauer *et al.*, 2004; Paustian *et al.*, 2004; Kurkalova *et al.*, 2004). However, in some instances where there is increased use of inputs, there may be risks of soil depletion through mechanisms such as acidification or salinization (Barak *et al.*, 1997; Díez *et al.*, 2004; Connor, 2004). Agricultural tillage practices for mitigation of GHGs and adaptation can have both co-benefits and costs on water conservation and on water quality. When mitigation measures such as reduced tillage promote water use efficiency, they provide potential benefits. But in some cases, the practices could intensify water use, thereby reducing stream flow or groundwater reserves (Dias de Oliveira *et al.*, 2005). Practices like reduced and zero tillage could reduce soil carbon loss and generate co-benefits like reduced soil erosion and degradation, runoff and nitrogen and positive water quality impacts (Schneider et al, 2007).

Practices that diminish productivity in existing cropland (e.g., set-aside lands) or divert products to alternate uses (e.g., bio-energy crops) may induce conversion of forests to cropland elsewhere. Conversely, increasing productivity on existing croplands may spare some forest or grasslands (West and Marland, 2003; Balmford *et al.*, 2005; Mooney *et al.*, 2005). Practices that reduce N_2O emissions often improve the efficiency of N use from these and other sources (e.g. manures), thereby also reducing GHG emissions from fertilizer manufacture and avoiding deleterious effects on water and air quality from nitrate pollutants (Oenema *et al.*, 2005; Dalal *et al.*, 2003; Olesen *et al.*, 2006; Paustian *et al.*, 2004).

Co-benefits from bio-energy crops include reduced nutrient leaching and soil erosion and additional environmental services such as soil carbon accumulation, improved soil fertility, removal of cadmium and other heavy metals from soils or wastes, and biodiversity benefits. They may also include increased nutrient recirculation, aid in the treatment of nutrient-rich wastewater and sludge; and provision of biodiversity habitats in the agricultural landscape (Berndes and Börjesson, 2002; Berndes *et al.* 2004). Intensification of agriculture and large-scale production of biomass energy crops may have costs, however, as they may lead to loss of biodiversity where they occur in biodiversity-rich landscapes (European Environment Agency, 2006), further clearing of natural habitats (either for biofuels themselves or for new agricultural land to replace converted crop lands), possibility of biofuel crops becoming invasive, and potential social and environmental costs like intensified competition for land and water and possibly deforestation. Some high-productivity, evergreen, deep-rooted bio-energy plantations generally have a higher water use than the land cover they replace (Berndes, 2002, Jackson *et al.*, 2005). Sustainable and or organic agricultural practices increase resilience to the health effects of climate change and provide more immediate co-benefits for health by protecting populations from extreme weather events, reducing risk of infectious disease, and improving air, soil, and water quality.

Forestry: Climate policies in forestry and ecosystem-based activities that generate co-benefits include stopping or slowing deforestation, afforestation and reforestation programs including forest plantations, restoration of wetlands, grasslands, and protected areas, and investment in biofuels and bioenergy opportunities. While promoting carbon sequestration, these policies also create co-benefits in the form of ecosystem services, watershed protection, reduction of soil erosion, and provision of fuel wood, timber and fodder. They also produce biodiversity benefits, especially through creation of a wider selection of species, planting of native species and accommodation of the range of needs of native wildlife needs. Forest plantations can have either positive or negative impacts on biodiversity depending on management practices. There are potential co-costs, however. Forest plantations may negatively affect biodiversity if they replace biologically rich native grassland or wetland habitats. Intensively managed plantations also have nutrient demands that may affect soil fertility and soil properties (Perez-Bidegain et al., 2001; Carrasco-Letellier et al., 2004), and changes in biological properties (Sicardi et al., 2004) if the choice of species is not properly matched with site conditions. Some of the tree species have high water demands that could lead to depletion of surface and groundwater resources.

Transport: Climate policies in the transportation sector include improving the efficiency of motorized vehicles and transport system, promotion of mass transit, policies (including land use measures) to reduce congestion on road, highways and urban metropolitan centers, and promotion of non-motorized transport. These policies produce co-benefits in the form of reductions in local air pollutants leading to improvement in air quality and health benefits, reduction in congestion, noise and accidents (HEATCO, 2006; Syri *et al*., 2001; Aunan *et al*. 1998; McKinley *et al*. 2003; Transport for London, 2006). Other examples of transport policies with significant co-benefits include internalizing the marginal social costs caused by freight transport types (Beuthe *et al*., 2002), and decreasing truck weight (MacKinnon, 2005; Leonardi and Baumgartner, 2004). While there are many synergies in emission controls for air pollution and climate change, there are also trade-offs. Diesel engines, for instance, are generally more fuel-efficient and have lower CO_2 emissions than gasoline engines, but they increase particle emissions, generating co-costs (Kahn et al. 2007).

Water: In the water sector, improving distribution and usage efficiency and reducing waste has been found to generate significant co-benefits (Canadian Water and Wastewater Association, 2009). Renewable energy systems such as hydro-electricity can contribute to the security of energy supply and protection of the environment but may also cause ecological impacts on existing river ecosystems and fisheries, induced by changes in flow regime (the hydrograph) and evaporative water losses, in the case of dam-based power-houses. Positive effects are flow regulation, flood control, and availability of water for irrigation during dry seasons (IPCC, 2007). Bio-energy crops raised with waste water and sludge also generate co-benefits in the form of habitats for biodiversity in the agricultural landscape, soil carbon accumulation, improved soil fertility, and removal of cadmium and other heavy metals from soils or wastes (Borjesson, 1999; Eriksson & Ledin, 1999).

Health: Outcomes from climate actions in the health sector are generally derived from intermediate environmental outcomes, such as reductions in urban air pollution. Haines and others (2009) highlight a range of positive health impacts resulting from strategies to reduce GHG emissions, including reductions in non-communicable diseases such as acute respiratory infections and heart disease, linked to improved cooking stoves and generation of electricity from renewable and low-carbon sources. Markandya and others (2009) focus specifically on low-carbon electricity generation and the potential health benefits in the European Union, China and India. In both China and India, the health benefits from clean electricity are substantial, with the value of health benefits in India simulated to actually exceed the incremental costs of carbon emission reductions in 2030.

3. Examples from the World Bank Portfolio

A sampling of the World Bank[3] project portfolio for this paper has highlighted a broad variety of opportunities for environmental co-benefits of climate change mitigation and adaptation actions, and vice versa[4]. (See outline in Table 3 and details in Annex 2.) The portfolio review includes the same sectors and similar classification challenges as in the literature review.

Table 3: Examples of projects with co-benefits based on a selected World Bank portfolio review

Project	Description	Mitigation benefits	Adaptation benefits	Environmental Co-benefits
Agriculture				
Agricultural Carbon Project - Kenya	Carbon sequestration through adoption of sustainable land management practices. Increased yields and productivity are expected.	Carbon sequestration	Enhanced resilience to climate variability through improved productivity.	Reduced soil erosion and depletion of soil nutrients.
Mainstreaming Sustainable Cattle Ranching - Colombia	Adoption of Silvopastoral Production Systems for cattle ranching	Carbon sequestration and reduction of methane emissions	Reduced farmer vulnerability to climate change impacts on cattle	Improved natural resource management, and enhanced environmental services (biodiversity, land, carbon, and water)
Ecosystems/Biodiversity				
TIEN SHAN ECOSYSTEM DEVELOPMENT- Kyrgyz Republic.	Improved ecosystem management and sustainable forestry	Carbon sequestration in forest biomass	Increased potential for water retention and snow harvesting.	Improved eecosystem management, biodiversity, water conservation
Water				
Oum Er Rbia Sanitation- Morocco	Improved wastewater and treatment systems	Odor reduction and methane capture for potential productive uses		Waste water treatment, improved local sanitation
Bioenergy Sugar Ethanol Wastewater - Thailand	Reduced GHG emissions	Reduced methane emissions from waste water treatment		Improved water quality through improved water treatment

[3] Includes the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA).
[4] Climate (mitigation and adaptation) benefits of environmental actions

Transport				
EDSA Bus Reduction Project - Philippines	Reduced GHG emissions from buses.	GHG (CO2) emissions reduction		Reduced air pollution along the highway
Sustainable Urban Transport Project - India	Promotion of environmentally sustainable urban transport	GHG emissions reduction		Reduced emissions of air pollutants resulting in health co-benefits
Forestry				
Shandong Ecological Afforestation - China	Demonstration of afforestation models for environmentally degraded areas	Carbon sequestration		Water conservation, reduced soil erosion, increased biodiversity, improved landscape and micro climate, and protection of agricultural land
Mid Himalayan Watershed Management Project - India	Pilot to improve rural livelihood through carbon sequestration by adaptive environment friendly technologies based on watershed treatment practices	Carbon sequestration	Increased recharge capacity of local aquifers	Reduce soil loss, biomass productivity, local biodiversity conservation, recharge capacity of local aquifers by 20%.
Energy				
Coal-Fired Generation Rehabilitation - India	Improvement of energy efficiency of selected coal-fired power generation units	Reduction of GHG emissions		Improvement of air pollution (reduction of PM10, SO_2, NO_x)
Eco-Farming - China	GHG emissions reduction through methane combustion and reduced burning of coal and firewood	The annual emission reduction amount estimated to about 60,000 ton $C0_2$.		Improved sanitation, better air, soil and water quality.

The main messages emerging from the portfolio review are:

- Many energy and transport sector projects address GHG emissions reduction as well as local air pollution emissions.

- Water sector projects bring adaptation benefits in some cases through strengthening resilience to increased weather variability.

- Emissions reduction or methane gas recovery can create carbon credits in a cost-effective way, while improving environment quality through cost-effective waste management and environmental management.

- Multi-benefit projects, all mapped under agriculture or forestry sector, improve carbon sequestration and reduce farmers' vulnerability to changing climate, while improving soil productivity, reducing soil erosion, or conserving biodiversity.

- Global Environment Facility (GEF) additional grant funding and carbon finance have both played a key role in addressing environmental co-benefits of mitigation actions. Considering also that some projects categorized under IBRD/IDA are co-financed by other funds such as the CIF's Climate Technology Fund (CTF), financial incentives are critical for addressing climate co-benefits.

- More co-benefits are addressed through exploring environmental consideration in mitigation actions rather than through exploring mitigation benefits in environment interventions.

- The review shows that while environmental impact assessments flag adverse impacts and co-costs, the co-benefits are usually not given credit. There is a need to develop a way to maximize these benefit opportunities for client countries,.

Apart from the project-based approach, some countries have embarked on a broader initiative to address co-benefits in more comprehensive manner, such as the example of the Andhra Pradesh Drought Adaptation Initiative (see Box 1 below).

Box 1: The Andhra Pradesh Drought Adaptation Initiative (AP-DAI)

In Andra Pradesh, India, conservation of water resources poses an enormous challenge to locals as competition for water increases in the face of potential scarcity and loss of quality. Climate change could accelerate water deficit and impact on the most vulnerable livelihoods. The AP-DAI project aims to reduce vulnerability to climate risks and change by increasing local resilience while reinforcing sustainable use and protection of natural resources.

In AP-DAI, adaptation co-benefit measures to protect the environment and adapt to climate change are mainly related to soil, land, and water management. Examples of these actions include increased soil erosion control; better soil and water management to improve soil water content, soil fertility, and enhancement of groundwater recharge; afforestation and rural energy management to meet household fuel needs; and livestock management and pasture development to increase diversification of income. With regard to common property resources, better management of water storage tanks results in opportunities for fish farming while improved management of common land is important not only for grazing livestock but for reducing run-off and improving rainwater infiltration into groundwater aquifers. Mitigation co-benefits are mainly related to increasing the stock of carbon in soil and/or in above-ground vegetation. This opens up opportunities and incentives for co-financing this type of adaptation project with various voluntary carbon funds. In addition, mitigation actions involve reduction of GHG gases by livestock and land management.

In order to ensure completion of the objectives, APDAI must be complemented by a set of institutional and policy conditions allowing the innovations to take root in society (continue protection of environment and provision of ecosystem services) and to be sustained in the institutions responsible for their scaling-up.

4. Enabling Conditions

While conceptually the idea of co-benefits (and co-costs) is easy to appreciate, ensuring that environmental co-benefits are realized requires enabling actions on the part of both the client country and the World Bank.

Client actions

Policies and regulations: Governments that have or are establishing a Green Growth strategy may provide a fertile ground for capturing co-benefits in their assessment and implementation of policies. This includes coordination across sectors and agencies to increase the capture of positive synergies. However, in some cases policies can become barriers, such as when bio-fuel cultivation is driven by energy security concerns, or fuel subsidies are established for political reasons.

Financing: This is an issue for both the client country and the Bank. If projects with larger co-benefits are more costly, then additional financing will be needed, and the Bank will need to have financing sources that can be tapped. IBRD and IDA can meet these financing needs, but it may be possible to leverage GEF finance or other grant-based resources as well. Financing is also linked to the carbon market, as noted, but this will depend on standards of eligibility for projects that provide co-benefits as well as additional GHG reductions.

World Bank actions

Economic analysis of projects: Valuing the co-benefits of projects will increase the overall measurable net economic benefits. This requires increased valuation of environmental benefits in project design as well as appraisal, including the benefits of foregone damages if the alternative project was dirty (coal power generation with weak emission controls, for example).

Knowledge: Guidance is needed for identifying and maximizing potential co-benefits in project design and implementation. Knowledge products will also have to support the co-benefit portion of project economic analysis, particularly valuation of environmental costs and benefits. This will entail more than the gathering and management of existing knowledge. Because knowledge in this area remains limited and the community of practice is still relatively small, a significant investment will need to be made to improve the tool box and increase its application. Innovative approaches should be considered, such as the use of the Global Expert Teams (GETs), e-learning modules, and tailored clinics. Creative mechanisms could be used to apply the knowledge to amend existing projects with new climate information and economics. The World Bank Institute (WBI) could be very helpful in furthering the knowledge agenda related to co-benefits.

Project design: The development objective needs to be explicit for capturing co-benefits, so that mechanisms for monitoring (including indicators) are put in place throughout the results chain. However, this also represents new and additional efforts that need to be resourced, as there is a knowledge gap that must be addressed in the context of Bank operations, especially in the case of adaptation options.

Institutional coordination: Co-benefit creation may span institutional boundaries, which will require senior management commitment to coordination across operational and sectoral Vice Presidential Units. This is no less true within the client country. However, implementation may still be a challenge unless coupled with incentives at the working level.

5. Implications for the Environment Strategy

The framework presented in this paper can be very helpful in enhancing communications with stakeholders and shareholders alike. While climate change is a divisive issue between developed and developing countries, there is overall agreement on the need for significant additional financing for climate action. If that financing can be leveraged to deliver both local and global benefits, there may be room for agreement on how the additional funds can best be used to maximize development and environment benefits.

The framework can also help leverage the high level of interest in climate change within the Bank and in client governments towards policy actions that are important for core environment and development objectives, and which may have been neglected. Good examples include the emerging links between natural capital conservation and climate change adaptation, and addressing urbanization issues and GHG mitigation.

Specific implications for the Environment Strategy include:

<u>Leveraging interest in climate change</u>. Co-benefit provision needs to become part of the policy dialogue and country strategy development with client countries, particularly given the growing level of interest in climate change in Ministries of Finance and Planning.

<u>Sectoral focus</u>. It is clear that co-benefits will be concentrated in the energy, transport, agriculture, ecosystem and biodiversity, forest, NRM, and water sectors. This can help focus priorities for the Strategy. But to succeed in establishing priorities, much more needs to be invested in co-benefit assessment to see how it might change strategic priorities when considering climate change.

<u>Innovative finance for conservation</u>. Wetlands, mangroves, and conservation forests merit increased efforts at conservation as natural assets which will increase climate resilience, as well as sequestered carbon. But these will not be traditional conservation projects, such as the creation of a national park, and so may require new sources of finance.

<u>Guidance to staff</u>. Staff guidance dealing with the identification of co-benefits, trade-offs and co-costs, with examples from the project portfolio, will enable wider application of co-benefit capture.

<u>Knowledge and analysis</u>. Because co-benefits would increase the measured net economic benefits of climate change projects (and the reverse for co-costs), there will be increased need for analytical tools to quantify co-benefits and to value them. This in turn will require a significant investment in knowledge creation as well as knowledge management by the Bank: to refine and augment relevant tools for applications in client countries, and to increase their application in and impact on Bank business. This is a high-priority initial step in order to be able to assess how co-benefits can leverage climate change interest, and the higher-priority opportunities for taking action.

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Annex 1: Climate policies in priority sectors - Global climate impacts and co-benefit opportunities

1. Agricultural sector policies and co-benefit opportunities: Carbon sequestration and adaptation policies in agricultural sector

Policy action	Global climate benefits	Local co-benefits	Co-costs	References
Afforestation of agricultural lands	Carbon sequestration	Reduced soil erosion Reduction in nitrate pollution and nitrate in surface and ground water Reduction in atrazine pollution Enhanced wildlife habitat Improvement in water quality		Plantinga and Wu (2003)
Retiring agricultural lands	Carbon sequestration	Reduction in sediment loads in watersheds Reduction in nitrate pollution and nitrate in surface and ground water Improvement in water quality Reduction in atrazine pollution and other agricultural chemicals		Feng, Cling and Galssman (2007)
Conservation tillage practices such as no till, ridge till, or chisel plough planting	Reverse the loss of soil carbon on croplands and promote C sequestration	Reduced soil erosion Reduction in nitrate pollution and nitrate in surface and ground water		Lal (2004) DeFries *et al.*, 2004 Viner *et al.*, 2006
Reduced fertilizer application and manure management	Reduction in emissions from fertilizer industry	Ecosystem benefits-less pollution from fertilizers		Freibauer *et al.* (2004)
Planting cover crops and reduce fallow periods	Soil carbon sequestration	Reduced soil erosion and sedimentation Reduction in nitrate pollution and nitrate in surface and ground water	Some cover-crops may become invasive	Paustian *et al.*(2004)
Raising bio-energy crops	Carbon sequestration	Reduced agricultural pollution from fertilizers and chemicals	Deplete water resources if water use efficiency of the genotype is low	Berndes (2002) Freibauer *et al.* (2004)
	Substitution of fossil fuels with bio-fuels	Reduce soil erosion and sedimentation	May deplete soil nutrients	
	Soil carbon accumulation	Improvement in soil properties,	Possibility of bioenergy crops becoming invasive species	

1. **Agricultural sector policies and co-benefit opportunities: Carbon sequestration and adaptation policies in agricultural sector**				
Policy action	**Global climate benefits**	**Local co-benefits**	**Co-costs**	**References**
		Biodiversity impacts-flora biodiversity Biodiversity impacts-increased insect, soil, invertebrate and avian diversity Better visual impacts Reduce nitrate leaching Provide habitats for biodiversity in the agricultural landscape Reduce soil erosion Increase nutrient recirculation, aid in the treatment of nutrient-rich wastewater and sludge	Diverting croplands to bio-energy crops by induce deforestation Possible impacts on biodiversity when bio-energy crops are raised in grasslands and set aside areas	
Reduced use and management of manufactured fertilizers, nitrate fertilizers	Reduction in GHG emissions from fertilizer industries Reduction in N2O emissions	Phytoremediation (polishing): removal of nitrates, cadmium, other nutrients and heavy metals from municipal waste, agricultural drainage, and sewage sludge If the bio-energy crop is deep-rooted perennials it may prevent land degradation and increase soil quality		Dalal et al. (2003) DeFries *et al.*, 2004 Viner *et al.*, 2006
Organic agriculture and sustainable agricultural practices	Both an adaptation and mitigation strategy	Reduction in nitrate leaching and water pollution Increases resilience to health impacts from climate change Health co-benefits by protecting populations from extreme weather events Reduces risk of infectious diseases Improves air, soil, and water quality		Kurkalova, Kling, and Zhao (2004)

2. **Climate policies in forest and ecosystem sector: Co-benefit opportunities**				
Policy action	**Global climate benefits**	**Local co-benefits**	**Co-costs**	**References**
Climate policies in natural ecosystems				
Aforestation and reforestation	Reduction in CO_2 emissions Carbon sequestration	Reduced nitrogen deposition Ecosystem services Watershed protection Reduced soil erosion Biodiversity benefits		
Restoration of wetlands that include swamp forests, mangroves, peat lands, mines and marshes	Carbon sinks that store/sequester carbon	Protection for large mammals (tiger, rhino, tapir, etc.), migratory birds and breeding populations of rare birds and animal species, spawning and nursery grounds for inshore fisheries Protection of mangroves provide ecosystem services including coastal defense, protection against extreme weather events		Balmford *et al.*, 2005
Restoration/preservation of grasslands like grazing management, protected grasslands and set-aside areas, grassland productivity improvements and fire management	Terrestrial carbon storage/sinks	Biodiversity benefits preserving grassland dependent birds, plant species and herbivore species		Mooney *et al.*, 2005
Preserving protected areas	Reduces emissions from habitat degradation Serves as a buffer against impacts of climate change	Biodiversity and ecosystem services		Berndes and Börjesson, 2002 Berndes *et al.* 2004

2. Climate policies in forest and ecosystem sector: Co-benefit opportunities				
Policy action	**Global climate benefits**	**Local co-benefits**	**Co-costs**	**References**
Promotion of biofuels and bio-energy crops	Substitute fossil fuels and thus reduce emissions		Clearing of natural habitats, either for biofuels themselves or for new agricultural land to replace converted crop lands Intensified competition for land and water and possibly deforestation Clearance and loss of natural ecosystems, with consequent loss of biodiversity Deforestation	Berndes (2002) Freibauer *et al*. (2004) Perez-Bidegain *et al.*, 2001; Carrasco-Letellier *et al.*, 2004
Climate policies in forest sector				
Increasing or maintaining forest area, Reducing deforestation and forest degradation	CO_2 mitigation, avoided emissions and carbon sequestration	Biodiversity conservation Protection of watershed Prevention of land/soil degradation Amenity values, nature preserves Aesthetic and recreational values Conserve water resources Reduces sedimentation and silting		
Afforestation/ reforestation	CO_2 mitigation and carbon sequestration	Biodiversity conservation Protection of watershed Prevention of land/soil degradation Amenity values, nature preserves	Mono-specific plantations replacing biodiverse grasslands or shrub lands may affect biodiversity Soil properties might be negatively affected in case of some species Use of water-hungry species deplete water resources Losses in stream flow	Sicardi *et al., (*2004)

2. **Climate policies in forest and ecosystem sector: Co-benefit opportunities**				
Policy action	**Global climate benefits**	**Local co-benefits**	**Co-costs**	**References**
		Aesthetic and recreational values Conserve water resources Reduces sedimentation and silting		
Agroforestry	CO_2 mitigation and carbon sequestration	Biodiversity conservation Protection of watershed Prevention of land/soil degradation Amenity values, nature preserves Aesthetic and recreational values Conserve water resources Reduces sedimentation and silting	Use of water-hungry species deplete water resources Losses in stream flow	
Forest management in plantations	CO_2 mitigation and carbon sequestration	Biodiversity conservation Protection of watershed Prevention of land/soil degradation Amenity values, nature preserves Aesthetic and recreational values Conserve water resources Reduces sedimentation and silting	May affect biodiversity if they replace biologically rich ecosystems	

Sustainable management of native forests	CO_2 mitigation and carbon sequestration	Biodiversity conservation Protection of watershed		
		Prevention of land/soil degradation Amenity values, nature preserves Aesthetic and recreational values Conserve water resources Reduces sedimentation and silting		
Bioenergy production from forests	Reduced emission from substitution of fossil fuels by bioenergy fuels	If production of fuel wood is the objective it may prevent deforestation	May affect biodiversity if a single species replace biologically rich ecosystems Short rotation plantations may cause land degradation and affect water and soils	Berndes (2002) Freibauer *et al*. (2004)

3. Transportation sector policies: Co-benefit opportunities				
Policy action	**Global climate impacts**	**Local co-benefits**	**Co-costs**	**References**
Improving efficiency of transport systems				
Renovation of taxi fleet	Reduction in road transport emissions	Reduction in particulate matter		HEATCO, 2006; Syri *et al*., 2001; Aunan *et al*. 1998; McKinley *et al*. 2003; Transport for London, 2006
Promote use of natural gas Introduction of hybrid buses	Reduction in emissions Reduction in GHG emissions from road transport	Local air quality benefits		

Internalize marginal social cost of freight transport types	Shift from trucking to rail and waterways	Reduction in congestion Reduction in local air pollution		Beuthe *et al*. (2002)
Heavy vehicle fee policy in Sweden, UK and Netherlands	Decrease in CO_2 emissions	Noise pollution reduction Local air quality benefits		Beuthe *et al*. (2002)
Promotion of non-motorized transport; For example in India	Decrease in CO_2 emissions	Local air quality benefits Health benefits		Aunan *et al*. (1998)
Use of diesel engines	Lower CO_2 emissions		Increase particle and NOx emissions	Kahn et al. (2007)
Policies o reduce congestion on roads, highways and urban center				
Mass transit and metro expansion	Reduction in GHG emissions from road transport	Health benefits-improvement in local air quality		HEATCO, 2006
Congestion charge in the city of London	Decrease in CO_2 emissions from transport sector Reduction NOx emissions	Local air quality benefits Health benefits Reduction in particulate matter		McKinley *et al*. (2003) Transport for London, 2006
Develop mass transit systems in urban centers	Decrease in CO2 emissions from transport sector	Local air quality benefits		
	Reduction NO_x emissions	Health benefits Reduction in particulate matter		

4. Climate policies in the energy sector: Co-benefit opportunities				
Policy action	**Global climate benefits**	**Local co-benefits**	**Co-costs**	**References**
Policies to reduce CO2 emissions				
Carbon tax	Reduction in CO_2 emissions	Reduction in particulate concentrations, SO_2 and thus local air pollution benefits. Reduction in premature deaths and cases of bronchitis	The carbon tax may lead to higher prices for electricity and modern fuels leading to increase in use of biomass and other traditional fuels and thus increased indoor air pollution and health costs.	Garbaccio, R.F., M.S. Ho and D.W. Jorgenson (2000)
Carbon tax on crude oil	Reduction in CO2 emissions		Increase in price of crude oil may lead to increase in oil prices and consequent increase in use of solid fuels and biomass which results in indoor air pollution and health impacts	Mazzi, E., and H. Dowlatabadi (2005),
Carbon pricing	Reduction in CO2 emissions	Reduction in SO2 and particulate matter concentration and health benefits		Garg, and others (2003)
Combining CO2 emission reduction policies with local air quality improvement programs	CO2 reduction	When tCO2 reduction is combined with LAP improvement policies the total costs were found to be less and thus results in a win-win situation		Chae, Y., (2010)
Integrated mitigation of SO2, NOx and CO2 to achieve the LAP and GHG emission reduction targets	GHG gas emission reduction	Integrated mitigation of SO2, NOx and CO2 could reduce average air pollution control costs significantly		Van Harmelen and others (2002)
Emission trading mechanisms to control	CO2 Emission reduction under Kyoto scenarios	Savings in local air pollution control costs		Van Vuuren and others (2006)
Introduction of a global carbon price	Global GHG emission reductions	Co-benefits could cover a sizable part of the mitigation costs and avoided costs of LAP policies		Bollen and others (2009)

Promotion of renewable energy				
Tap into wind energy for electricity generation Generation of electricity from hydro-power plants Solar power generation	Avoided emissions from electricity generated from wind sources	Local air quality benefits	Loss of aesthetic values Impacts on avian species	
Sewage and biogas energy for electricity generation for lighting	Avoided emissions from electricity generated	Indoor air quality benefits from substitution of kerosene lamps		Borjesson (1999); Eriksson and Ledin (1999)
Use of geothermal, energy from seawater currents	Avoided emissions from electricity generated			
Generation from landfill gases	Reduction in CO2 and methane emissions	Local air quality benefits		
New/improved technology-CO2-abating for coal based power plants- Clean coal technology, co-generation, Modified boiler design, Boiler replacement, Improved boiler management, Coal washing, and Briquetting	Reduction in CO2 emissions	Reduction in local air pollution from SO2 and Nox and consequent health benefits		Aunan et al. (2004)
Fuel switching from coal fired power plants to less CO2 intensive technologies	Reduction in CO2 emissions	LAP and health benefits from reduced Particulate Matter, SO2 and other local air pollutants		
Carbon capture from large point sources- Installation of carbon capture mechanisms	Reduction in CO2 emissions	Reduction in local air pollution from SO2 and Nox and consequent health benefits		

5. Climate policies in water and waste water: Co-benefit opportunities				
Policy action	**Global climate benefits**	**Local /cobenefits**	**Co-costs**	**References**
Improve efficiency of distribution	Reduced energy usage inwater sector	Water conservation		Canadian Water and Wastewater Association, 2009
Hydropower generation	Avoided GHG emissions	Flow regulation and flood control Availability of water for irrigation during dry seasons	Ecological impacts on catchment areas, ecosystems Impacts on river ecosystems	IPCC (2007)
Raise bio-energy crops with waste water and slufge	Reduce methane and landfill gas emissions	Local air quality benefits Habitat for biodiversity in the agricultural landscape Soil carbon accumulation Improved soil fertility Removal of cadmium and other heavy metals from soils or wastes		Borjesson (1999) Eriksson and Ledin (1999)

Note: Global climate benefits mentioned above include other adaptation and mitigation benefits.

Annex 2: Summary of results from the FY 09 and FY10 Portfolio Review

Objective

A portfolio review was undertaken as part of the study to identify co-benefits with adaptation to and/or mitigation of climate change in the projects targeted to environment protection and vice versa.

Methodology

Projects reviewed are either those approved or in pipeline in FY 10 (as of May 10, 2010) under the product line of IBRD, IDA, GEF and GEF medium size. In addition, FY09 projects review was done with Energy, Transport, and Water sector to underpin the review. These sectors are selected according to the results of the literature review indicating stronger linkage with climate change than other sectors.

Projects selected were filtered for Environment Theme Codes (Biodiversity, Climate Change, Environmental policies and institutions, Land administration and management, Pollution management and environmental health, Water resources management, Other environment and natural resource management) to find the benefits for adaptation to and mitigation of climate change in environment-related portfolio, and environment benefits of climate-related projects. Projects screened in this way are 155 in total with 103 for FY10 and 52 for FY09, which excluded the projects without project document available.

In this study, co-benefits were assessed simply by reviewing project documents for their project objectives, thematic coverage and project components. The assessment was undertaken in a relatively conservative way. Environmental benefits were reviewed in terms of quality of environmental media, the flow of ecosystem services and maintenance of biodiversity, in consistency with the framework of this study. Mitigation benefits were assessed against emission reduction of greenhouse gases (e.g. CO_2, methane and nitrous oxide), while quantitative assessment of the reduced amount is not attempted. In this study, projects addressing "Mitigation benefits" are limited to those being explicit in emission reduction.

On the other hand, identifying adaptation benefits in project documents was more challenging since adaptation efforts are highly integrated in the development projects and currently no indicator exists, as opposed to mitigation. For instance, an intervention strengthening resilience to increased risk of drought would constitute adaptation measures to climate change only if future climate is taken into account, and it fits the future climate scenario projected. However, due to its time-lag, the risks posed by climate change are often missed out. Aware of the complexity, this study limits the boundary of projects with "adaptation benefit" to those explicitly addressing strengthened resilience/adaptation to changing climate.

Findings

Overall

Some of the project documents reviewed provide a partial to full listing of co-benefit opportunities. Projects with adaptation co-benefits are found most in agriculture and water sector. Mitigation co-benefits are found most in energy sector followed by waste management, agriculture and transport sector. Multi-benefit projects (with mitigation, adaptation and environment benefits) are limited to agriculture sector. In general, the adaptation benefit has been sought through the activities such as capacity building, awareness raising or institutional strengthening as opposed to the mitigation benefits with emission reduction. Projection of future climate or estimated emission reduction was hardly undertaken except for GEF-financed of carbon financed projects. Few project PADs provide qualitative analyses of co-benefits.

Co-benefits projects reviewed are distinguished by its project design into two; projects addressing both climate and environment benefits simultaneously by using a single technology/technique under one component and projects bringing co-benefits at project level by attaching environment components into climate component and vice versa. An example of the former includes rehabilitation projects of coal-fired plant to introduce more efficient technology resulting in improved air pollution and emission reduction of carbon dioxide. The latter, on the other hand, includes methane capturing from landfill gas with consideration with leachate prevention which provides additional benefit to simple mitigation project. Almost all the project identified falls into the second category.

Several projects address multi benefit with mitigation, adaptation and environment. Most multi-benefit projects are mapped under agriculture or forestry sector, which improve carbon sequestration and reduce farmers' vulnerability to changing climate, while improving soil productivity, reducing soil erosion, or conserving biodiversity. Water sector is another potential area for multi-benefit but no project was identified in this study.

Co-benefits for each sector

Water sector projects bring adaptation benefits in some cases through strengthening the resilience to increased weather variability (e.g. flood or drought). A Small hydroelectric project in Honduras is expected to bring social and environmental (both air and water) benefits as well as the mitigation benefit. A water resources management project in Peru aims to improve the resilience to expected impacts of climate change, such as increased variability of runoff and intensification of floods and droughts. However project review showed that some opportunities for addressing co-benefits with climate action seem to exist though are not explicitly addressed, as the case of flood and watershed management project in China - that contributes to strengthening resilience to flood but did not explicitly address adaptation to a changing climate.

Agriculture sector projects present a unique opportunity to capture all of the benefits on adaptation, mitigation and environment including improved productivity, sustainability and adaptation of agricultural sector under changing climate, prevention of land degradation, soil erosion, biodiversity conservation and carbon sequestration. Co-benefits projects under this sector cover wide range of project from small methane capturing from livestock waste management to large scale land management projects. For the *forest* sector, quite a few projects under the Forest Carbon Partnership Fund and GEF projects are seeking these multi benefits, though their main objectives and approaches are different.

The objectives of the *energy sector* projects reviewed were mainly increasing efficiency of power plants, upgrade and rehabilitation of coal-power plant, biogass power generation, gas flaring reduction and so on. Climate benefit of energy projects is emission reduction of carbon dioxide (CO2) associated with energy generation and its environmental benefit is air pollution reduction such as NOx, Sox or PM, often resulting in improved health impact. Estimated environmental benefits brought about by the projects are highly dependent on the alternative technologies to be compared with or the existing technologies to be replaced.

The largest number of mitigation co-benefits project falls under energy sector and the hurdle for addressing co-benefits seem to be lowest in light of the fact both benefits can be easily assessed quantitatively. Thermal Power Efficiency project in China, for example, quantified benefits both for climate and environment to be incorporated into project economic analysis.

Objective of *Transport* project includes inducing mode switching away from private vehicles, reduced road congestion, improved air quality and CO2 reduction. Co-benefits opportunities explored are relatively large.

As seen in a landfill gas recovery project in Philippines, and a livestock waste management project and wastewater management project in Thailand, emission prevention or recovery of methane gas can create carbon credits in a cost effective way, while improving environment quality through cost effective waste or environment management.

The general objectives of projects that fell under the theme natural resource management are improved management of flora and fauna, natural habitats, watershed and landscapes through capacity building, empowerment of communities, development of institutions and direct assistance. The co-benefits identified include sustainable management of water, land and natural resources and adaptation benefits, improved productivity and sustainability of ecosystems, biodiversity conservation, reduced flooding; watershed management.

Financing

The review showed that the funding source is a determinant in the treatment of co-benefit opportunities. For instance, the GEF additional grant funds must, as per the conditions for GEF financing contribute to global environmental benefits as well as local benefits and hence co-benefit opportunities tend to be mainstreamed in GEF projects. In particular, GEF financing seems to help exploring adaptation opportunities more than others (Table 1).

Table 1: Link of funding sources with co-benefits

	co-benefits w/ adaptation	co-benefits w/ mitigation	benefits w/ adaptation &mitigation	Total # of co-benefits projects	
					co-benefits of all (env and cc) projects
IBRD/IDA	7	10	2	**19**	26.7% of (71 projects)
Carbon offset	0	**18**	2	**20**	62.5% (of 32 projects)
GEF	**8**	9	**6**	**23**	44.2% of (52 projects)

The review further showed that carbon funding plays a key role in addressing environmental co-benefits of mitigation actions. About a half of co-benefits projects for mitigation are financed by various carbon funding. Above others, Community Development Carbon Fund, aiming at extending the benefits of carbon finance to the poor communities, would be characterized for its innovative project with co-benefits for local environment. One of the imperatives for carbon financing in addressing environmental co-benefits is scaling up the projects that are relatively small

Considering also that some projects categorized under IBRD/IDA project line are co-financed by other funds such as Climate Technology Fund, financial incentives such as GEF or carbon financing are critical in addressing the climate-benefits. A scheme for covering incremental cost for monitoring or assessing emission reduction or resilience to changing climate would enable to explore huge opportunities for climate benefits in existing environment portfolio and vice versa.

As seen in table 2 below, more of mitigation co-benefits are addressed through exploring environmental consideration in mitigation actions rather than through exploring mitigation benefits in environment interventions, considering the ratio for aggregate cc-themed and aggregate env-themed is opposed to the ratio of mitigation co-benefits. This might be because more demand for incorporating environment benefits comes from client countries compared with the demand for addressing mitigation benefits.

Table 2: Climate change action with environment benefit(s) VS environment action with climate change benefit(s)

	adaptation		mitigation		adaptation and mitigation		***(Total # of projects reviewed)***
thm1 =cc	4	27%	29	**78%**	5	50%	(49)
thm1=other env.	11	73%	8	**22%**	5	50%	(107)
Total	15	100%	37	100%	10	100%	

For co-benefits project with adaptation, further analysis is required, to find which approach are taken more often than the other of the path starting from environment or the path starting from climate change.

Regional distribution

The percentage of co-benefits projects of all environment-targeted projects (including climate change) range from about 20% to 60%. The rationale for this diversity could not be identified through reviewing project documents, and more detailed analysis is necessary. In all regions except for MENA, the number of mitigation projects exceeds those for adaptation.

Other findings

The operational policy of the World Bank requires completion of an Environmental and Social Impact Assessment and development of plans to mitigate such adverse impacts. However, the operational policies do not suggest valuing the co-benefits and mainstream these opportunities in project design and evaluation. The review shows that while environmental impact assessments flag adverse impacts, co-costs, the co-benefits are not given credit.

There is no guidance on quantification of environmental co-benefits in project design and appraisal. So there is a need to develop guidance and tool to maximize these benefit opportunities for the client countries, in some cases with only marginal investments.

Some projects seem to have addressed the global benefits to maintain the consistency with CAS. Climate change DPL in Indonesia is innovative as it highlights and promotes bringing the co-benefits of climate action for environment improvement. Higher strategy or broader policy lending might be a vehicle for co-benefits projects that is influential over individual projects. Institutional arrangement might be another key (i.e. engagement by institutions in charge of climate change), though the supporting information was not obtained from the review.

Many unique and innovative projects addressing mitigation and other environmental concerns were found under carbon offset project. Most of these projects are in pilot phase and relatively small in their size. Scaling-up these relatively small projects would be another imperative to overcome.