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An investigation of the evidence of benefits from climate compatible development

Emma L. Tompkins, Adelina Mensah, Lesley King, Tran Kim Long, Elaine T. Lawson, Craig Hutton, Viet Anh Hoang, Chris Gordon, Marianne Fish, Jen Dyer, and Nadia Bood

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An investigation of the evidence of benefits from climate compatible development

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Contents

Abstract

Climate change is likely to have profound effects on developing countries both through the climate impacts experienced, but also through the policies, programmes and projects adopted to address climate change. Climate change mitigation (actions taken to reduce the extent of climate change), adaptation (actions taken to ameliorate the impacts), and on-going development are all critical to reduce current and future losses associated with climate change, and to harness gains. In the context of limited resources to invest in climate change, policies, programmes, or projects that deliver 'triple wins' (i.e. generating climate adaptation, mitigation and development benefits) – also known as climate compatible development – are increasingly discussed by bilateral and multilateral donors. Yet there remains an absence of empirical evidence of the benefits and costs of triple win policies. The purpose of this paper is therefore to assess evidence of 'triple wins' on the ground, and the feasibility of triple wins that do not generate negative impacts. We describe the theoretical linkages that exist between adaptation, mitigation and development, as well as the trade-offs and synergies that might exist between them. Using four developing country studies, we make a simple assessment of the extent of climate compatible development policy in practice through the lens of 'no-regrets', 'low regrets' and 'with regrets' decision making. The lack of evidence of either policy or practice of triple wins significantly limits the capacity of donors to identify, monitor or evaluate 'triple wins at this point in time. We recommend a more strategic assessment of the distributional and financial implications of 'triple wins' policies.

Key words:

climate resilience, low carbon growth, co-benefits, climate compatible development, Kenya, Vietnam, Ghana, Belize, coast, climate policy

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1. Introduction

Climate change has the potential to significantly influence international development potential by changing both exposure to hydro-meteorological hazards and the vulnerability context (Lemos et al., 2007). This is likely to occur through three main routes: the variability and extremes could change of important climatic events on which poor people rely e.g. monsoon rains, or for which they need to prepare e.g. floods (Cruz, 2007, Randall et al., 2007). In some parts of the developing world, climate change will place additional stress on those already living in poverty, through trend changes such as reduced rainfall, or a rising sea level that can worsen local living conditions or make some places uninhabitable (Boyd et al., 2009a). As climate zones shift, people previously not in poverty may be pushed into this group as existing livelihood strategies may not be adequate under the changing climate (Tanner and Mitchell, 2008). International development resources are expected to be stretched to meet the growing demands under a changing climate (Stern, 2006).

In the context of a global economic recession, there is a growing demand for cost-effective international development assistance. For example, notions of 'value for money', accountability to tax payers, and transparency of spend have become new objectives of the UK Department for International Development (DFID, 2012). This new agenda means that resources previously spent on development assistance are now spent on supplementary auditing and evaluation to determine cost effectiveness. Squeezed between a reduction in the supply of international resources to support international development, and a growing demand for resources to address developmental challenges in a changing climate, developing countries are facing difficult choices. To address this problem, donors are making an increasingly audible call to support climate policies that deliver 'triple wins', i.e. action on climate change adaptation, mitigation or development, that produce additional climate change and development benefits (GDPRD, 2011).

The concept of 'triple wins' originated in the form of 'climate-smart agriculture': "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals" (FAO, 2010: ii). *Climate resilience, climate smart agriculture*, and *climate compatible development (CCD)* are now often used to articulate the same idea – i.e. a single policy with multiple benefits for climate change adaptation, mitigation and development. The notion of 'triple wins' has been suggested for application in the developed world, for example by Sir John Beddington, the UK Government's Chief Scientific Advisor, who uses the 'perfect storm' analogy to articulate resource scarcity challenges imposed by finite natural resources, a growing population and climate change. Beddington argues that this emerging perfect storm requires us to adopt new ways of thinking about how we provide global food security – 'triple wins' may be one such approach (DEFRA, 2011).

There is limited evidence of the theoretical links between adaptation and mitigation (Klein et al., 2007). Some researchers argue that adaptation and mitigation should be treated separately as they are undertaken by different people at different spatial scales (Tol, 2005). Others note that adaptation and mitigation policies should be assessed jointly to identify the optimal policy mix within integrated assessment models (Kane and Shogren, 2000); and others highlight that at the individual level, adaptation and mitigation are often undertaken jointly as part of daily risk and resource management (Tompkins and Adger, 2005, Tompkins et al., 2010). Yet planning and policy making for climate change often takes place in the absence of clear guidance on how to assess the conflicts, trade-offs and synergies between adaptation, mitigation and development actions.

It is in this poorly evidenced space that policy makers are now considering maximizing multiple benefits from joint action on adaption, mitigation and development. To move forward on this issue, this paper considers two specific questions: i) what evidence is there of multiple benefits from pursuing triple wins policies; and ii) are there potential losses associated with triple wins policies? To address these questions, we first consider the framing of triple wins. We then describe examples of triple wins in terms of the trade-offs and synergies that exist in coastal areas within four coastal countries in Asia, East and West Africa and Latin America (Vietnam, Kenya, Ghana and Belize). These countries have been selected as they are all developing countries with long coastlines, which are prone to climatological stressors, and which have the potential to reduce emissions through programmes such as REDD+[1]. The paper concludes with an assessment of the future potential of triple wins policies.

2. Climate adaptation and mitigation: the foundations of climate compatible development

Climate compatible development (CCD) is an increasingly used, but still contested term referring to both the desired outcome of climate change policy and the shape of the policy itself. As a policy goal, CCD describes the conditions that allow a community or nation to bounce back from and prosper in the face of climate stress. CCD policies aim to deliver green growth while at the same time supporting people's ability to adapt to climate change. To better understand the potential for synergies between adaptation, mitigation and development, we first conceptualise adaptation and mitigation.

Climate adaptation tends to be delivered through four main routes: reductions in existing vulnerabilities to past and present stressors, building adaptive capacity, risk management to address current and future risks, or building long term resilience to climate change (Eakin et al, 2009, Ensor and Berger, 2010, and McGray et al 2007). Adaptations most often occur locally and reactively in response to real or perceived climate threats (Adger et al., 2007). At the national level, adaptation is frequently driven by government action (Tompkins et al, 2010), and most often focusses on reducing existing vulnerabilities or building adaptive capacity (McGray et al, 2007). There is significant research on individual aspects of adaptation in developing countries, specifically vulnerability reduction and disaster risk reduction, but far less on building adaptive capacity and building longer term resilience (Berrang-Ford et al., 2011). Much of the literature on vulnerability reduction and climate change articulates a very clear link between adaptation and development (Schipper and Pelling, 2006, Pouliotte et al., 2009, Klein et al., 2005, Jerneck and Olsson, 2008), or mitigation and development – when appropriate institutional mechanisms are put in place (Boyd et al., 2009b, Brown and Corbera, 2003). Indeed within the vulnerability reduction literature it is often difficult to discern a difference between the adaptation or mitigation activity and development practice.

[1] They also form part of an 18 month CDKN project 'Achieving triple wins: identifying climate smart investment strategies for the coastal zone', funded from August 2011 to February 2013.

Mitigation activities can be broadly grouped into five main areas: efficient use of energy (i.e. reducing system waste); use of renewable energies (such as solar, biofuels, wind, ocean thermal exchange); carbon sequestration through enhanced sinks (e.g. reforestation, afforestation); reduced sources of emissions through land use management, and macro-engineered carbon capture and storage (following Boyd and Tompkins, 2010). In this paper we consider only the first four as geo-engineering remains a potential rather than a real option for most developing countries. Research has identified that most emissions reductions can occur in those sectors where these four mitigation activities are most feasible, i.e. energy supply, industry, buildings, transport, agriculture, forestry, and waste management (Metz et al., 2007). Research on mitigation has focussed largely on developed countries, with the exception of research into tropical forestry – where the relative importance of mostly developing country forests as carbon sinks has been debated (van der Werf et al., 2009). In the coastal zone, where research has started to consider how much organic carbon is stored in tropical wetland forests, initial estimates suggest that tropical wetlands may be among the largest terrestrial stores (Donato et al., 2011). There seem to be many reasons to conserve mangroves for developmental benefits; this new research shows that there are potentially also mitigation co-benefits.

It is only recently that there has been speculation about the potential links between adaptation and mitigation in developing countries (see for example Halsnæs and Verhagen, 2007). The few papers that exist highlight the role of ecosystems in enabling these links. Recent work identified that transforming waste into compost can be a means of improving soil quality in drought-prone areas, while also reducing methane emissions (Ayers and Huq, 2009). Another example with possible four-fold benefits (reduced flooding vulnerability, enhanced carbon storage in tropical wetland forests, biodiversity conservation / restoration and increased fisheries productivity) is the restoration of coastal wetlands to regulate water flow and to reduce the risk of flooding during storm surges (Jones et al., 2012). These two examples indicate that triple wins appear to exist, where one action can generate adaptation, mitigation and development benefits (see Figure 1).

Figure 1 Potential climate change triple wins

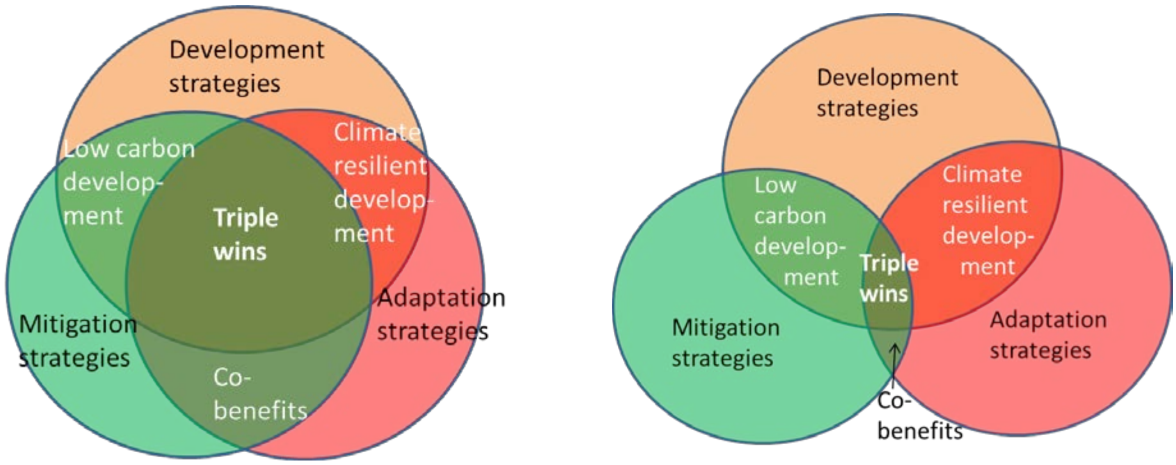


Fig 1a: Large potential benefits between adaptation mitigation and development

Fig 1b Small overlap between, adaptation, mitigation and development

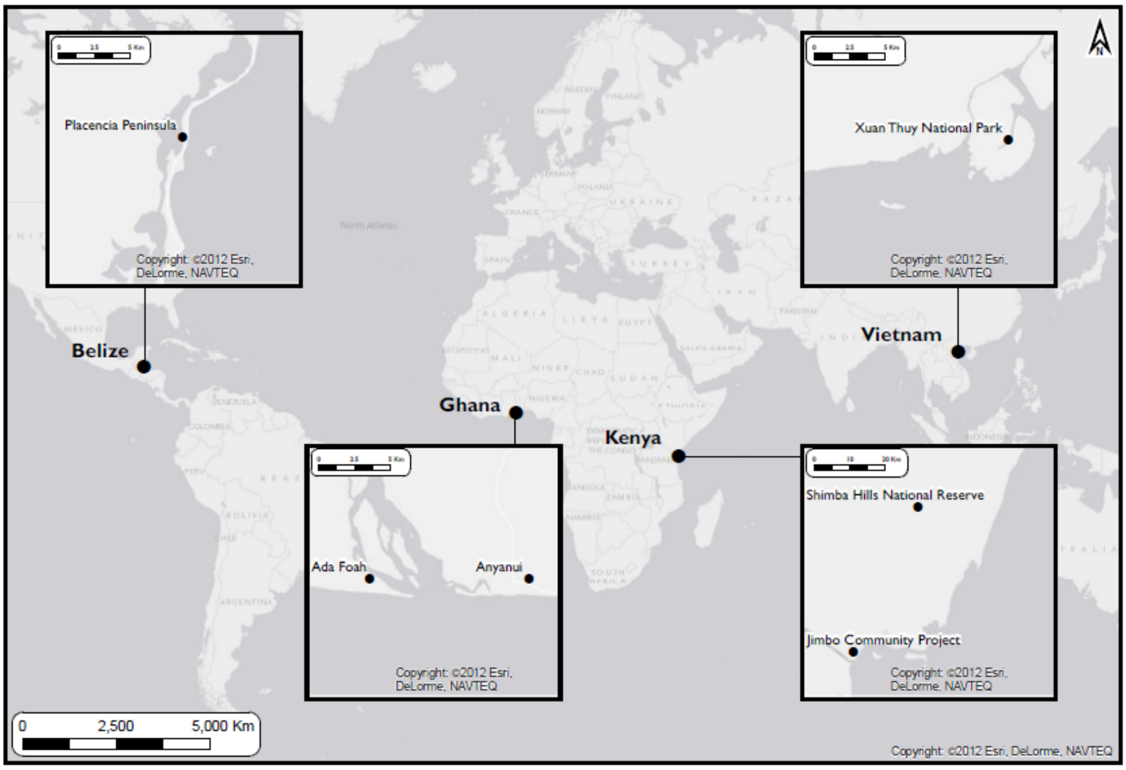
What remains unclear is whether the potential benefits from 'triple wins' are large (Fig 1a), or a relatively small component of all adaptation, mitigation and development actions (Fig 1b)? It is also unclear whether there can be concurrent negative impacts associated with triple wins. To better understand the significance and extent of triple wins, and whether there can be concurrent negative impacts, we consider a range of triple wins in four coastal countries. Coastal areas are a relevant unit of analysis as they are already experiencing climate impacts, through coastal inundation, soil salinisation, and coastal erosion (Nicholls et al., 2007) , all of which are likely to increase. The IPCC estimates that coastal adaptation is often a less expensive option than inaction – considering property losses and human health impacts (IPCC, 2007). Coastal areas are also important economically and socially and hold significant potential for low carbon development due to: access to renewable energy resources (such as solar, wind, ocean thermal and wave energy), the availability of international funds for mitigation, and the presence of large and growing populations.

3. Empirical evidence of triple wins in Belize, Ghana, Kenya and Vietnam

A variety of coastal locations in Belize, Ghana, Kenya and Vietnam (see Figure 2) are used to explore the potential for triple wins from policies relating to agriculture, aquaculture, fisheries, forestry, and tourism. These four sites were selected to offer an initial insight into triple win potential in four very different areas in the developing world: namely southeast Asia, east Africa, west Africa, and Latin America and the Caribbean.

The Belizean case study area is the Placencia Peninsula and Lagoon, Stann Creek District, Belize. There are four communities along the peninsula, with coral reef systems and offshore mangrove cayes to the east, and a large biologically diverse lagoon and mangrove forest to the west. The area has been significantly impacted by tourism development, aquaculture, overfishing as well as climate impacts (Bood and Fish, 2012). In Ghana, the case study is located in the Volta Estuary, where multiple pressures on natural systems such as fishing, tourism and forestry (exacerbated by climate change) are reducing ecosystem services, adaptation capacity and removing greenhouse gas sinks (Gordon et al., 2011).

Figure 2: Map of case study locations



The Kenyan case study is situated in Kwale district, Coast province which is particularly susceptible to rising sea levels, coral reef bleaching, extreme weather events including droughts and flooding, sedimentation and coastal erosion (Kithiia & Dowling 2010; Maeda *et al.* 2011). There are few national level activities yet occurring there to support the adaptation or mitigation of climate change (King, 2011). The Vietnamese study considers Xuan Thuy National Park, south of Ba Lat River mouth. This park became a RAMSAR site in 1989, and in 2004 a biosphere reserve within the Red River Delta. The park contains an important wetland ecology system that provides habitat for many bird species, however the area is subject to: very high population density, high levels of poverty, and a dependence on agriculture and fishing. As a result there has been high natural resource degradation through shrimp, clam and oyster farming. Coastal defences in the area are frequently damaged by tropical cyclones, riverine flooding, and coastal erosion (Hoang et al., 2011).

In each location, climate adaptation and mitigation activities are already being undertaken or planned, see Tables 1 and 2.

Table 1 Examples of policies, programmes and projects contributing to adaptation

Contribution	**Belize**	**Ghana**	**Kenya**	**Vietnam**
Reduce vulnerability	2020 Development Plan for the Placencia Peninsula, to balance conservation of mangroves with development.	Potential new income through sustainable harvesting of local products such as reeds and mangroves.	Encourage agroforestry to enable poor rural households to meet energy and subsistence needs	National Strategy for Forest Sector Development: Build integrated and sustainable agriculture and aquaculture system
Build adaptive capacity	'Ecosystems, Development and Climate Adaptation' project: to improve knowledge base for coastal planning, policy and management.	Private sector investments to boost adoption of scientific practices in breeding and production of fingerlings and enhance fish stock management	Strengthen co-management and community-based management institutions, and the ability to enforce restrictions	National Strategy for Agriculture and Rural Development (2011-2020) Introduce saline resistant rice variety for yield stability, & boost productivity.
Disaster risk reduction	Engage and empower communities in local disaster risk reduction strategies	Education and early warning mechanisms to encourage storage and preservation of fish during bumper harvests	Create natural protective barriers against the sea so as to prevent its interference with the usual land practices	Build and strengthen dyke sea systems to minimize damages from floods and storms
Build climate resilience	Establish and preserve greenbelts and buffer zones between sea and farm infrastructure to reduce impacts	Conserve ecologically sensitive areas such as mangroves and biodiversity such as marine turtles supported by local communities	Encourage a coastal and watershed basin management approach linking land-use practices to marine and fisheries resource conservation	National Target Programme on Climate Change: protection of existing mangrove and planting new mangrove forest

Sources: (Bood and Fish, 2012, King, 2011, Gordon et al., 2011, Hoang et al., 2011, Forest Science Institute of Vietnam (FSIV) and FAO, 2009)

Table 1 highlights that a variety of actions are being undertaken that can be defined as adaptation, i.e. they reduce existing vulnerabilities, build capacity to cope with shocks, deliver disaster risk management or contribute to climate resilience. Each country adopts a very different approach to delivering adaptation (which is dependent on local drivers of vulnerability and the climate hazards faced). Interestingly, all four countries are building climate resilience in the same manner – by focussing on supporting the ecosystems that provide ecosystem services for adaptation.

Table 2 highlights some of the mitigation policies, programmes and projects occurring in the case study sites in Belize, Ghana, Kenya and Vietnam. Many different mechanisms are being implemented to encourage widespread use of renewable sources of energy. There is also evidence of high levels of activity in terms of encouraging energy efficiency – possibly due to the correlation between energy efficiency and cost savings, which could have developmental benefits. Higher levels of activity in the area of carbon sequestration through sinks are occurring, possibly due to the recent development of financing mechanisms such as Payment for Ecosystem Services (PES) and Reduced Emissions from Deforestation and Degradation (REDD+). However there are far fewer examples of reduced sources of emissions through land use management.

Table 2 Examples of policies, programmes and projects contributing to climate mitigation

Contribution	*Belize*	*Ghana*	*Kenya*	*Vietnam*
Efficient use of energy	Private sector aquaculture use of algae in ponds to reduce need for of high aeration	Improved fish landings facilities to reduce post-harvest fisheries losses and increase waste recycling	Promote energy conservation initiatives and efficient charcoal production and utilisation technologies	Encourage households to use low-energy / firewood saving stoves through local associations
Use of renewable energy	Small scale solar energy explored at local levels	Renewable Energy Bill provides a feed-in tariff mechanism to encourage adoption and use of renewable energy	Renewable energy (incl. geothermal) policy pursued as alternative to carbon-based energy (i.e. fuel-wood and charcoal)	Review national hydropower system and prioritise multi-purpose options providing: flood control, electricity, water regulation, and irrigation
Carbon sequestration through sinks	National analysis to develop policy guidance on how Belize can capitalize on REDD+	Protection and improved management of wetlands	REDD+ promoted and supported including action to mobilise the necessary finance.	Build mechanisms to share benefit from Payment for Ecosystem Services and REDD+ at the community level
Reduced sources of emissions through land use management	None identified	Improved land tenure systems to encourage farmers to adopt sustainable farming	Careful management of agricultural waste e.g. using waste to produce biogas	Construction / improvement of irrigation systems for de-acidification, de-salinization of soil

Sources: (Bood and Fish, 2012, King, 2011, Gordon et al., 2011, Hoang et al., 2011, Obirih-Opareh et al., 2010, Forest Science Institute of Vietnam (FSIV) and FAO, 2009)

The initiatives described in Tables 1 and 2 are now discussed in detail.

3.1 Adaptation, mitigation and development in Belize

Adaptation to climate change has been recognised as a key element within Belizean climate policy since 2000 (Government of Belize, 2000). Nonetheless, a 2008 evaluation of the country's ability to adapt revealed that while basic structures are in place to reduce the country's vulnerability to climate change, a number of gaps remain (Neal et al., 2008). On-going research is highlighting areas in need of adaptation planning. For example aquaculture faces a variety of challenges from climate change, including: i) increased risk of harmful algal blooms and changes in metabolic rates of farm species linked to rising sea surface temperatures and ii) loss of land function, saline penetration, changing estuary dynamics and loss of mangroves from sea level rise. These problems can be managed but industry and communities need to develop their own plans to monitor risks and if needed address them (Gillett and Myvette, 2008). Despite various research projects identifying and recording climate risks, there remains the need to improve the knowledge base for planning, policy and management of Belize's coastal ecosystems (Devisscher et al., 2010). To address these issues, and as part of the wider climate policy initiative, a range of new plans (see Table 1) are being developed (Bood and Fish, 2012).

Parallel activities are being undertaken to address climate change mitigation. In Belize, the vast majority of greenhouse gas emissions are generated by land use change and forestry (92%), the energy sector is the second highest contributor (Government of Belize Land and Surveys Department, 2009). Bood and Fish (2012) identify a range of activities occurring in some areas of mitigation i.e.: efficient use of energy; use of renewable energies; and carbon sequestration (see examples in Table 2). The majority of mitigation activities identified by Bood and Fish (2012) relate to introduction of renewable sources of energy – which can bring developmental co-benefits by supporting low carbon growth; or carbon sequestration through enhanced management of sources of emissions. It is interesting to note that mitigation activities appear to be occurring in all areas, even in manufacturing. For example, Bood and Fish (2012) note that the beer industry is piloting methane capture and recovery.

3.2 Adaptation, mitigation and development in Ghana

Adaptation activities that relate to fisheries are among the most important in Ghana as fish accounts for 65% of total animal protein consumed in the country, even though the sector makes a relatively small contribution to GDP. Even though the fisheries sector only contributes 3% of total GDP, it engages about 10% of the country's population (Neiland, 2006). Tourism is a growing sector, dependent on coastal ecosystems (beaches, mangroves, estuaries and wetlands), as well as historical artefacts (such as forts and castles). This sector is now Ghana's fourth highest foreign exchange earner (Tweneboah and Asiedu 2009). There are significant conservation and development co-benefits from adaptation and between the two subsectors, precisely because both sectors depend on the maintenance of the ecological character of coastal habitats (Gordon et al., 2011). While adaptation activities in these two sectors are informed by national strategies such as the Ghanaian National Climate Change Adaptation Strategy (NCCAS) and the Ghanaian Climate Change Adaptation and Development Initiative (CCDARE), no specific sectoral adaptation plans exist. In the absence of larger sectoral plans, adaptation appears to be undertaken largely at the local level, based on indigenous practices and traditional understanding of ecosystem dynamics - although these are very poorly documented (Gordon et al., 2011). Examples of current adaptation actions occurring in Ghana are documented in Table 1.

Climate mitigation is already occurring in Ghana, and a variety of options are being implemented or have already been implemented (Environmental Protection Agency of Ghana, 2011). Renewable energy supplies are being introduced but remain a tiny fraction of total energy use. While 90-95% of Ghana's domestic energy production comes from woodfuels, renewables from hydro energy account for 5-10% of output, and solar energy produces less than 1% (Environmental Protection Agency of Ghana, 2011). In the mountainous southeast of the country wind speeds have been recorded at 9 m/s indicating the potential for wind energy development (Environmental Protection Agency of Ghana, 2011). Further the Ghanaian Strategic National Energy Plan (2006-2020) recognises that liquid biofuels could be important for the future of the transport sector. To better integrate renewable energy sources into the national energy grid mix, the new Renewable Energy Act 2011 (Act 832) provides for a feed-in tariff mechanism to encourage the adoption and use of renewable energy. This is particularly important in Ghana where 41% of greenhouse gas emissions are from the energy sector (Environmental Protection Agency of Ghana, 2011).

Carbon capture and sequestration through sinks is important in Ghana's emissions inventory. Due to successive governments' investment in reforestation, afforestation, plantation programmes, as well as sustainable forest management interventions (i.e. in Land Use Change and Forestry – LUCF) Ghana's LUCF sector now contributes about 10% of net greenhouse gas removals (Environmental Protection Agency of Ghana, 2011). To support this area investments are also being made in: protection and improved management of wetlands; mangrove rehabilitation and reforestation, and community resource management (Gordon et al., 2011).

3.3. Adaptation, mitigation and development in Kenya

The National Climate Change Response Strategy (NCCRS) sets out the potential threats posed by climate change, as well as some of the national projects and programmes proposed to adapt to and to mitigate climate change (GoK 2010). Kenya is actively addressing climate change through a variety of programmes including: promoting growth of drought tolerant, pest resistant and disease resistant species; developing country-wide maps depicting areas that will require shoreline protection and those to be left to adapt naturally; and, improving timber yields by planting mixture of species, maintaining several age classes, reducing tree density, and pruning trees at strategic intervals (King, 2011). The NCCRS will be superseded by the Climate Change Action Plan but this is still being drafted and is not expected to be available until late 2012.

In East Africa, the introduction of REDD+ means that addressing climate change through the forestry sector is growing at a faster pace than other sectors (Cerbu *et al.* 2011). In 2010, Kenya also published its national strategy for REDD+ as a means of reducing emissions in the forestry sector (GoK 2010). Other sectors are only recently being addressed through the development of the Nationally Appropriate Mitigation Actions (NAMA). This UNFCCC-led initiative focusses largely on energy, transport and agriculture as sectors for mitigation of climate change (Murphy *et al.* 2012). The largest area of activity (as with Ghana) is in the promotion of renewable energy sources such as geothermal as an alternative to carbon energy sources such as charcoal and fuelwood. Also, as in Ghana, the opportunity to change emissions trajectories through management of land use has been recognised. This policy is being delivered through application of agricultural technologies to increase food production while simultaneously limiting or reducing GHG emissions, such as low conservation tillage and fire management; enhanced management of agricultural waste, e.g. using waste to produce biogas; encouraging improved crop production practices; promotion of afforestation/reforestation and REDD to reduce emissions and enhance carbon sinks and promoting organic farming (King, 2011).

3.4 Adaptation, Mitigation and development in Vietnam

In Vietnam adaptation is mostly occurring though vulnerability reduction. Actions include: improving rural livelihoods and supporting the creation of alternative income generating sources such as mushroom growing and bee keeping. Adaptive capacity is being supported through information dissemination about weather and climate risks and the potential impacts on local livelihoods such as clam farming, and training the forest protection management board and local farmers in how to better manage biodiversity in natural mangrove forests. Risk reduction is supported by protecting mangroves in the core and buffer zones of the Xuan Thuy national park, and resilience is being strengthened by increasing forest and vegetation cover in the national park (Hoang et al., 2011).

In terms of mitigation, there are a variety of initiatives being undertaken. Renewable energies are being promoted, for example policies are encouraging the use of agricultural waste products (cattle or pig manure) as an alternative to fossil fuels or wood; incentives are available for the private sector to generate and use renewable energy; and the recent review of the national hydropower system recommends prioritizing hydro-power options that are multi-purpose, i.e. that provide electricity, water regulation and flood control, and irrigation (Hoang et al., 2011). Energy efficiency is being driven through a restructuring of industry, away from energy-intensive industry towards energy efficient industry. To support this, the government is reviewing the energy pricing system to make energy efficiency more economic, and requiring large commercial and industrial consumers to prepare energy efficiency plans, and then requires compulsory energy audits. Further funding is being allocated to conserve existing forests such as the Xuan Thuy national park (Pham, 2007) and to support large scale afforestation such as the Five Million Hectare Reforestation Program – program 661 (Barr and Sayer, 2011).

4. Trade-offs and synergies: The reality of triple wins from climate change adaptation and mitigation policies and programmes

Balancing environment and development needs has long been recognised as a matter of managing the multiple objectives of different stakeholders, and finding trade-offs and synergies between conservation and development, (UNEP, 2004, WCED, 1987, Ostrom, 1990). Climate change brings a destabilising influence to this balance by making it more difficult to identify clear winners and losers or clear successes and failures (O'Brien and Leichenko, 2003). For example, a new hydropower facility may harm smaller communities in the vicinity of the dam, but it may benefit the nation as a whole through provision of cheaper energy supply, domestic energy security, and greenhouse gas emissions reductions. The challenge for policy makers is to identify how to select the ‘best’ options when faced with both long term and wide spatial distribution of costs and benefits.

A desk-based assessment of the distribution of the positive and negative impacts (in terms of the effects on adaptation, mitigation and development) of the adaptation and mitigation examples listed in Tables 1 and 2 goes some way to revealing whether triple wins are possible and whether there can be concurrent negative impacts associated with triple wins. Examples of policies, programmes, and projects that are being implemented in the four countries (extracted from Annex 1) are presented in Tables 3, 4, 5 and 6.

Table 3 Examples of coastal management policy choices that deliver 'triple wins' and are 'no-regrets'

←--------------	Trade-offs	-----------→	Policy choice (country)	←---------------------------	Synergies / gains	------------------------------→
Development	***Mitigation***	***Adaptation***	***Policy***	***Adaptation***	***Mitigation***	***Development***
None identified	None identified	None identified	Conserving water catchment areas, river banks and water bodies (Belize, Kenya)	Improved access to water for forestry reduces fire risk in dry season	Carbon sequestration from improved riparian management	Improved riparian management and access to potable water Reduction in erosion and sedimentation, and flood easement
None identified	None identified	None identified	Mangrove restoration/ afforestation/ reforestation (Ghana, Kenya)	Natural storm defences	Carbon sequestration	Enhanced ecosystem services from healthy coastal ecosystems i.e. fisheries, timber, NTFPs
None identified	None identified	None identified	Use of aquaculture / agriculture wastes to produce biogas (Belize, Vietnam)	Improved resilience of coastal ecosystems from reduced waste inputs	Alternative energy supply, i.e. reduce emissions from fossil fuels	Healthier coastal fishery Healthier coastal ecosystems

Table 4 Examples of coastal management policy choices that deliver 'double wins' and are 'no-regrets'

←--------------	Trade-offs	-----------→	Policy choice (by country)	←--------------	Synergies / gains	-------------→
Development	***Mitigation***	***Adaptation***	***Policy***	***Adaptation***	***Mitigation***	***Development***
None identified	None identified	None identified	Co-management / community-based forest management (Kenya)	None identified	Emissions reductions Carbon sequestration	Improved fuel security Improved livelihoods from forests Fewer illegal activities prosecuted
None identified	None identified	None identified	Diversified livelihoods: agroforestry bee-keeping, silkworm rearing, *Aloe vera* production (Kenya)	None identified	Emissions reductions Possible carbon sequestration	Improved food security for local communities Improved livelihood options
None identified	None identified	None identified	Aquaculture eco-certification e.g. mangroves for pond effluent treatment (Belize)	Reduced pressure on coastal ecosystems enhancing natural buffer	None identified	Sustainable land management

Table 5 Examples of coastal management policy choices that deliver 'triple-wins' but which are 'low-regrets' or 'with regrets'

←--------------	Trade-offs / losses	-------------→	Policy choice (by country)	←--------------	Synergies / gains	-------------→
Development	***Mitigation***	***Adaptation***	***Policy***	***Adaptation***	***Mitigation***	***Development***
Loss of land for alternative development Planting of new mangroves in tidal flats is expensive and difficult	None identified	None identified	Mangrove restoration and management (Belize, Vietnam)	Shoreline protection Storm buffering	Expand carbon sinks	Payment for Environmental Services (PES), Ecotourism, Habitat protection for fisheries REDD+ financial benefits Possibility of more diversified mangrove-based livelihood
Loss of land for alternative development	None identified	None identified	Create greenbelts between coastal farms and sea (Belize)	Mangroves can migrate inland with SLR Increased protection from SLR and storm surges	Create carbon sinks	Reduce coastal impacts of adjacent land use practices
Damaging impact on fish nursery and feeding areas (poor construction)	None identified	Possible downstream erosion	Construction of offshore wind/wave or tidal energy (Ghana)	Potential protective barriers against storm surges	Alternative renewable zero-carbon energy supplies	Positive impact on habitat and stock enhancement (effective construction)

Table 6 Examples of coastal management policies that generate 'double wins' but that come 'with regrets'

←--------------	Trade-offs / losses	-------------→	Policy choice (by country)	←--------------	Synergies / gains	-------------→
Development	***Mitigation***	***Adaptation***	***Policy***	***Adaptation***	***Mitigation***	***Development***
Lack of rural infrastructure means benefits are slow to reach poor communities	Lack of rural infrastructure means biomass fuels continue to be used in rural areas	Potential for contributing to water shortages in Rift Valley if inappropriate techniques used	National policy to switch to geothermal and renewable energy sources (Belize, Kenya, Vietnam)	None identified	Emissions reductions	Improve fuel security
Resource ownership is not clear – risk of 'power grabs' and loss of benefits to poorer households	Emissions from fuel wood	None identified	Establish woodlots for fuel wood (Kenya)	None identified	Carbon sequestration	Better access to biomass-based fuel and NTFP[2]s Improved water retention in dry areas through green water
Higher sediment transfer affects coastal fisheries, tourism and agriculture Damage to natural beach ecosystems	Embedded carbon emissions in concrete Reduced carbon sink capacity from reduced function of coastal wetlands	Damaging impact on mangroves and wetland system affecting storm buffering capacity Change in sediment budget leading to erosion downstream	Engineered coastal defences incl. groynes, breakwaters, sea walls (Ghana, Kenya, Vietnam)	Protects adjacent community from coastal erosion and sea level rise	None identified	Coastal protection for adjacent agricultural land Protected agricultural production

[2] Non-Timber Forest Products

The evidence in these four tables was compiled from information contained in four reports produced as part of a Climate and Development Knowledge Network (CDKN) funded project (Bood and Fish, 2012; Gordon et al, 2011; Hoang et al, 2012; and King, 2011).

Table 3 lists examples of country-level actions that have been judged, by the researchers, to deliver 'triple wins' and are 'no-regrets' options. 'No regrets' implies that the actions are not expected to have negative developmental side effects, increase emissions or result in mal-adaptation[3]. Table 4 lists those actions identified as 'double-wins' that are also no-regrets. For example an adaptation action that also generates mitigation benefits (described as co-benefits in Fig 1a), or development benefits (climate resilient development in Fig 1a), while not creating additional greenhouse gas emissions, and not creating mal-adaptation. Table 5 provides examples of 'triple win' policies that are 'low-regrets' or 'with regrets' i.e. they may create maladaptation or negative impacts that will have to be managed. Table 6 depicts examples of policies that generate 'double-wins' but 'with regrets' – highlighting that supplementary benefits do not necessarily come without a cost.

Several observations are immediately obvious: i) local conditions determine whether a policy can be delivered with or without regrets; ii) policies that create a significant geophysical change are more likely to generate 'regrets' than 'soft' coastal management; iii) policies that deliver no-regrets co-benefits tend to be development-facing projects; and iv) projects that deliver no-regrets triple wins, tend to be targeted at adaptation or mitigation, v) the financing mechanisms of policy delivery can determine whether policies generate triple-wins or trade-offs.

In all four countries, soft environmental engineering approaches to mitigating climate change, such as mangrove restoration, appear to provide an important opportunity for triple wins. Mangrove conservation, afforestation and restoration can provide multiple benefits for mitigation (carbon sequestration, avoided land use change) adaptation (shoreline protection, storm buffering) and development (habitat protection, improved fisheries and ecosystem services, possible REDD+ benefits, ecotourism, NFTPs). Our study supports the hypothetical work that suggests that ecosystem-based climate adaptation can enhance coastal ecosystems' resilience (see for example Jones et al., 2012). However, the local conditions in which this policy is applied determines whether the outcome occurs with or without regrets, e.g. the appropriateness of species being used for restoration and whether there are ecological trade-offs. The policy of mangrove restoration in Ghana and Kenya appears to be without risks, whereas in Belize and Vietnam there are ancillary costs associated with this policy. There are many reasons why this is so: in Ghana and Kenya the policy is occurring in areas which are not highly populated, in Belize and Vietnam the areas in which the policy is to be implemented are highly populated, land is in short supply and in Belize has a high value for tourism development. In Kenya, attempts to generate benefits for communities through agroforestry (e.g. through intercropping and support for NTFPs) also generate negative impacts because issues of land tenure and governance remain unresolved. The conclusion from this is that the same policy implemented in different

[3] Following Barnett and O'Neill (2010) we define maladaptation as "action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups." (p.211)

countries can generate triple wins with no regrets, or triple wins with regrets – the governance context always need to be considered in estimating the potential for triple wins.

Policies that generate ‘regrets’, in Tables 5 and 6 are mostly those that involve construction of physical structures, or that involve land use change. In the case of hard-engineering fixes for adaptation or mitigation of climate change (e.g. through construction of sea defences, or dams for hydropower) there are likely to be mixed impacts: some benefits in terms of localised coastal protection, but some costs in terms of impacts on local livelihoods e.g. fisheries and tourism. However there are also likely to be changes in sediment transfer that could cause impacts to livelihoods on a wider geographic scale. Hard engineering options appear to produce significant trade-offs. In contrast, some forms of mangrove management could potentially generate the same gains as with the engineered structures without regrets. As before, the governance context plays a key role in the extent to which these triple wins can be harvested. The local acceptability of hard engineered alternatives need to be considered, as do the financial resources available to deliver the policy. For example, the cost of policy implementation (such as mangrove restoration in Belize create costs for coastal communities – Table 5) may fall on the already poor. In other cases, implementation costs may be covered by other sources, such as mangrove restoration in Kenya which is paid for out of REDD+ funds and adaptation funds.

Finally, all the policies that deliver triple wins ‘without regrets’ appear to be initiatives focussed on addressing climate change. Without deliberately and explicitly including climate change into development planning, the potential to hit the triple win is reduced. When climate change is the focus of an initiative, the potential to deliver triple wins ‘without regrets’ increases.

5. Conclusions

The idea that climate policy can deliver triple-wins in terms of adaptation, mitigation and development has progressed up the development agenda. Despite the growing use of the concept of triple wins, there is little empirical evidence of triple wins. This paper goes some way to addressing this research gap. Through four country studies we have shown that policies already exist that are delivering ‘triple wins’, there are some policies delivering ‘double-wins’ (or co-benefits), and there are some policies that are creating development losses, mal-adaptation and worsening emissions.

The simple analysis in this paper highlights an important conclusion: the simplified depiction of ‘triple-wins’ (as shown in Figure 1a) ignores the reality that policies designed to create triple wins can generate a raft of negative impacts at the same time as producing the triple wins. These negative impacts may be incurred as increased emissions, reduced capacity to adapt, or worsening poverty and may vary geographically – however the simplified, often cited diagram (e.g. Mitchell and Maxwell, 2010) depicting triple wins hides this reality from policy makers. Any policy that focusses on triple wins therefore must be evaluated equally on the benefits gained as well as the level of ‘regrets’ that must be borne to achieve those triple wins. Further there are general constraints that could limit the potential for triple wins in all areas, these include a lack of skills to implement policy locally, a lack of capacity to take up the possible benefits, and a lack of capital to support new initiatives by households that build on these policies – however these constraints are true for most development work.

While this research project has identified that triple wins occur, it has not tried to evaluate the extent of the triple wins, or compare the relative merits of different bundles of triple wins. This limitation highlights a significant research gap that needs addressing. Specifically, how can the multiple benefits be evaluated from adaptation, mitigation and development in a way that takes into account both the spatial and temporal costs and benefits that may accrue. New research in this area is likely to run into similar problems to research that aims to evaluate adaptation, i.e. how to manage long time frames, uncertainty and surprises, however this remains an important area of research to develop.

A third important conclusion from this research is that development-facing initiatives appear to have the potential to deliver co-benefits, however for triple-wins to be generated, it appears that coastal policies and projects developed need to be initiated with a clear adaptation or a mitigation purpose. Clearly this final conclusion needs significant research: to what extent do existing development initiatives already deliver triple wins? Are adaptation or mitigation policies more effective in generating triple wins? This very poorly developed field of research needs to engage more effectively with these questions to provide adequate evidence to the development community of the implications of pursuing a policy of triple wins. This call for research is urgent as there is already evidence that emphasising 'triple-wins' or 'sweet-spots' could potentially draw development funders (such as the UK Department for international Development - DFID) away from its core area of development, to only focus on those areas where adaptation, mitigation and poverty reduction coincide (House of Commons Environmental Audit Commitee, 2010: Ev 76). Without a strong evidence base, there is a risk that the development community could invest in policies that create triple wins with regrets at the expense of more effective policies that might only deliver co-benefits but with no-regrets.

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Annex 1: Policies, programmes and projects delivering triple wins and co-benefits in coastal areas of Belize, Ghana, Kenya and Vietnam

←--------------	Trade-offs / losses	-------------→	Policy choice (by country)	←--------------	Synergies / gains	-------------→
Development	***Mitigation***	***Adaptation***	***Policy***	***Adaptation***	***Mitigation***	***Development***
Triple wins policies with 'no regrets'						
•	•	•	Conserving water catchment areas, river banks and water bodies (Kenya)	• Improved access to water for forestry reduces fire risk in dry season	• Carbon sequestration	• Improved riparian management and access to potable water
•	•	•	Mangrove restoration/ afforestation/ reforestation (Kenya)	• Natural storm defences	• Carbon sequestration	• Enhanced ecosystem services from healthy coastal ecosystems i.e. fisheries, timber, NTFPs
•	•	•	Use of aquaculture wastes to produce biogas (Belize)	• Improved resilience of coastal ecosystems from reduced waste inputs	•Alternative energy supply, i.e. reduce emissions from fossil fuels	• Healthier coastal fishery
Co-benefits with 'no-regrets'						
•	•	•	Protect unaltered buffer areas along water-bodies (Belize)	•	•Carbon sequestration from improved riparian management	• Reduction in erosion and sedimentation, and flood easement
•	•	•	Co-management / community-based forest	•	•Emissions reductions • Carbon	• Improved fuel security •Improved livelihoods

			management (Kenya)		sequestration	from forests • Fewer illegal activities prosecuted
•	•	•	Agroforestry and alternative livelihoods e.g. bee-keeping, silkworm rearing, *Aloe vera* production (Kenya)	•	• Emissions reductions • Possible carbon sequestration	• Improved food security for local communities • Improved livelihood options
•	•	•	Aquaculture eco-certification e.g. mangroves for pond effluent treatment (Belize)	• Reduced pressure on coastal ecosystems enhancing natural buffer	•	• Sustainable land management
Triple wins with low-regrets						
• Loss of land for alternative development	•	•	Mangrove restoration and management (Belize)	• Shoreline protection • Storm buffering	• Increasing carbon sinks for peat development • REDD	• Payment for Environmental Services (PES), • Ecotourism, • Habitat protection for fisheries
• Loss of land for alternative development	•	•	Greenbelts between farms and sea (Belize)	• Mangroves can migrate inland with SLR • Increased protection from SLR and storm surges	• Create carbon sinks	• Reduce coastal impacts of adjacent land use practices
• Loss of tourism earnings due to	•	•	Managed retreat, including re-	• Improved protection	• Carbon sequestration	• Reduced sediment transfer leading to

loss of coastal land that is highly valued for tourism development			wetting wetlands (Kenya)	against sea level rise and coastal storms	from re-wetting wetlands	improved coastal ecosystem health
• Lack of skills / capacity / capital to start new livelihood activities by resident households • Planting of new mangroves in tidal flats is expensive and difficult	•	•	Mangrove and wetland conservation through land use zooming and restricted use (Vietnam)	• Enhanced storm buffering capacity and resilience to sea level rise	• Expansion of carbon sinks	• Options for more diversified livelihoods
• Damaging impact on fish nursery and feeding areas (poor construction)	•	• Possible downstream erosion	Construction of offshore wind/wave or tidal energy (Ghana)	• Potential protective barriers against storm surges	• Alternative renewable zero-carbon energy supplies	• Positive impact on habitat and stock enhancement (effective construction)
Co-benefits with regrets						
• Issues of land tenure may mean that benefits not felt by local communities	•	•	Plant climate resilient species (Kenya)	•	• Possible carbon sequestration (depends on speed of rotation and fate of timber)	• Improved timber yields • More sustainable timber industry (possibly employing more local people)
• Depleted water resources (?)	•	•	Afforestation (Ghana)	•	• Creation of carbon sink	• Improved ecosystem service function
• 45% of plantations are government owned in Kenya – the remainder are	•	•	Intercropping in plantations (Kenya)	• Increases resilience of agricultural land to climatic shocks	• Carbon sequestration	•

private						
• Lack of rural infrastructure means benefits are slow to reach poor communities	• Lack of rural infrastructure means biomass fuels continue to be used in rural areas	•	National policy to switch to geothermal and renewable energy sources (Kenya)	•	• Emissions reductions	• Improve fuel security
• Resource ownership is not clear – risk of 'power grabs' and loss of benefits to poorer households	• Emissions from fuel wood	•	Establish woodlots for fuel wood (Kenya)	•	• Carbon sequestration	• Better access to biomass-based fuel and NFTPs • Improved water retention in dry areas through green water
• Growth in farm size behind mangroves could limit ability of mangroves to retreat under sea-level rise.	•	•	Growth in / expanded footprint of aquaculture farms (Belize)	•	•	• Potential growth in livelihoods of aquaculture farmers, and on-farm employment
•	•	• Damaging impact on mangroves and wetland system affecting storm buffering capacity	Engineered coastal defences – construction of dykes (Vietnam)	•	•	• Coastal protection for adjacent agricultural land • Protected agricultural production
• Reduced water availability to some areas • Increased salinity in some coastal areas	•	•	Construction of new dams for hydropower (Ghana)	•	• Reduced emissions from fossil fuels	•

• Higher dissolved nutrient supply in coastal areas						
• Damage to natural beach ecosystems	•	• Change in sediment budget leading to erosion elsewhere	Engineered coastal defences (Ghana)	• Protects adjacent community from coastal erosion and sea level rise	•	•
• Higher sediment transfer affects coastal fisheries, tourism and agriculture	• Embedded carbon emissions in concrete • Reduced carbon sink capacity from reduced function of coastal wetlands	• Increases downstream erosion	Engineered coastal defences incl. groynes, breakwaters, sea walls (Kenya)	• Protects adjacent community from coastal erosion and sea level rise	•	•

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