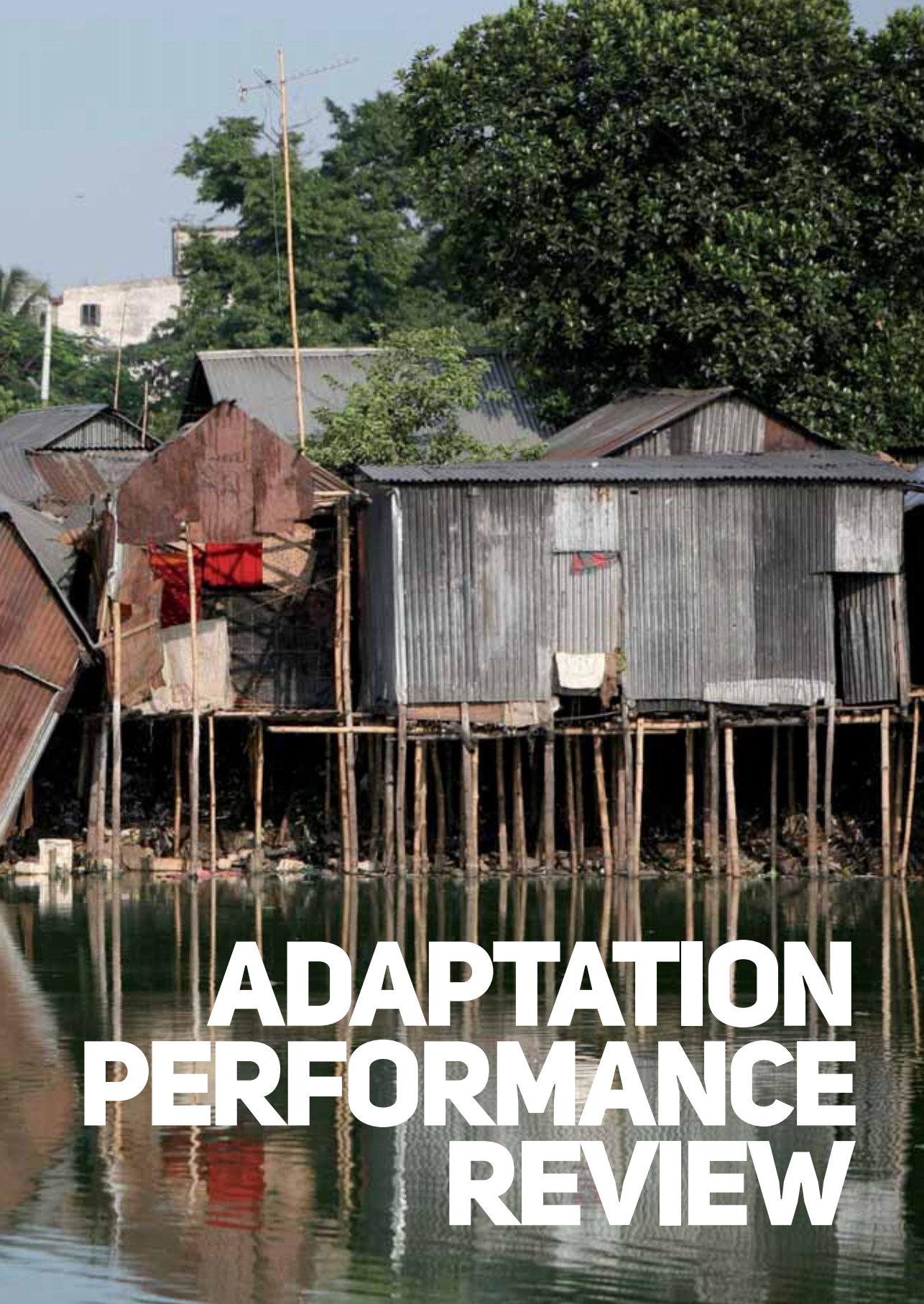
Slum houses in Dhaka, Bangladesh, raised above ground level to protect against flooding. Source: Manoocher Deghati/IRIN.



ADAPTATION PERFORMANCE REVIEW

ADAPTATION PERFORMANCE REVIEW

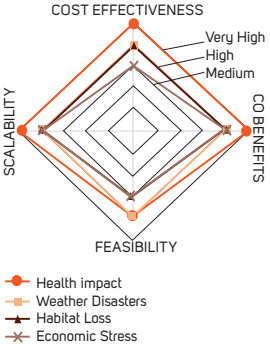
The Adaptation Performance Review assesses over 50 key measures that can be taken to reduce dangers and harm to communities and the planet across the four main impact areas of this report. Highly cost-effective actions exist for minimizing nearly every type of impact assessed in the Climate Vulnerability Monitor. Technically speaking, the human toll of climate change is entirely preventable and should be immediately addressed through reinforced financing to health and disaster-prevention programmes such as those examined in this report. For all other stress areas, efforts will likely have to be substantially stepped up if we are to avoid major, irreversible harm. As climate change intensifies, the costs of adaptation could escalate out of all proportion. So it is also extremely urgent that we take ambitious parallel action to stem greenhouse gas emissions, which are the principal cause of this growing challenge.

FINDINGS

A key conclusion of this Adaptation Review is that, while it is extremely inexpensive and feasible to address some impacts (especially those that are health-related), other impacts (especially those relating to loss of human habitat) are extremely expensive and much more challenging to implement. In some cases, top-down policies will be more cost-effective than bottom-up measures, although a combination of both is desirable. Ultimately, there is no excuse for inaction when a non-exhaustive study such as this is able to identify so many cost-effective options for tackling all of the main types of climate impacts. However, the difficult task of countering rising seas, drying lands, growing deserts, warming oceans, and melting glaciers will require massive investments in protection and conservation efforts.

Adaptation measures that address the health impact of climate change are generally the most cost-effective of the groups of actions reviewed here. Weather disaster responses are, on average, the next most cost-effective group, followed by measures for dealing with economic stresses. Battling the threats of habitat loss entails some of the most expensive actions and some of the least feasible. But even in this impact area, half of the measures reviewed here received either a high or very high rating, meaning cost-effective actions are still readily available even for addressing the most challenging of concerns.

REVIEW FINDINGS



Damage from Hurricane Ike in Bolivar Peninsula, Texas. Source: FEMA/ Jocelyn Augustino.

RESULTS OF ADAPTATION PERFORMANCE REVIEW BY IMPACT AREA				
EFFECTIVENESS RATING RECEIVED	**HEALTH IMPACT**	**WEATHER DISASTERS**	**HABITAT LOSS**	**ECONOMIC STRESS**
	% of all Measures Assessed (rounded)			
VERY HIGH	70	20	10	35
HIGH	30	60	40	25
MEDIUM	-	20	50	40
MOST FREQUENT VALUE	Very High	High	Medium	Medium
MOST FREQUENT EVIDENCE BASE VALUE	High	High	Medium	High

That said, in time it will become extremely difficult for the types of local-level measures examined here to meaningfully hold back global forces, such as the devastating impact of higher sea temperatures on coral, for example. Adaptation will increasingly involve choices about what to preserve, since enormous amounts of resources might otherwise be wasted on the impossible. In addition to the broader challenge of climate change, we may face tough choices of whether to prioritize adaptation, mitigation, or other development planning actions. And the choices we make could reduce the ability of some ecosystems or communities to withstand change. For example, building up small-scale hydro power plants as a way of reducing greenhouse gas emissions could exacerbate competition for already scarce water resources.[209]

ADAPTATION WILL INCREASINGLY INVOLVE CHOICES ABOUT WHAT TO PRESERVE

Where the impacts of climate change are most acute, adaptation will invariably have to be our top priority. But that decision could come at a further loss to economic or human development and might undercut any benefits of adaptation due to the close link between human development and climate vulnerability.

This problem underscores the express need to ensure that low-income communities highly vulnerable to climate change have access to adequate external resources. Compounded pressures could otherwise trigger vicious cycles in which promising options for responding to impacts quickly vanish as communities find themselves struggling to emerge from a crisis alone.

In analyzing possible measures for adapting to climate-related changes, the report was able to depend on a well-documented evidence base of previous experience that was fairly consistent and generally good. This is mainly because the areas of health, disaster reduction, and economic development include many well-established programmes that have been actively pursued by local communities or the health, development aid, disaster reduction or humanitarian relief domains for years, even decades. The impact area with the least robust evidence base reviewed was again habitat loss. Habitat loss impacts, such as widespread desertification, are relatively new compared to the other impacts looked at. It will take some time before responses to habitat loss have built up a readily accessible reference base equal to that of the other areas.

Communities under stress are already undertaking a number of adaptation measures on their own.[210] This so-called "autonomous adaptation" occurs when farmers and communities automatically adjust to climate-related changes and reap potentially beneficial effects. However, since the rate of change is accelerating, large-scale impacts are already outstripping the ability of the many vulnerable communities to persevere.[211] The levels of impacts outlined in the Climate Vulnerability Monitor describe the extent to which communities are already unable to autonomously adapt to the challenges they face today. Adaptation measures would have to be stepped up significantly in communities around the world, especially those with a vulnerability factor of high to acute, if these impacts are to be brought to a minimum.

Most measures taken to counteract negative impacts of climate change are also likely to bring substantial additional benefits for economic growth, socio-economic development, general disaster risk reduction, and the diminution of greenhouse gas emissions.

In particular, many of the measures reviewed here have clear benefits for each of the first 7 Millennium Development Goals (MDGs), which are the most internationally recognized targets in the fight against poverty. Measures relating to water, agriculture, and malnutrition all clearly address the first MDG, which focuses on the eradication of extreme poverty and hunger and is seeing some of the slowest progress of all the goals.[212] Many health measures aimed at climate-sensitive diseases will have wide-ranging beneficial effects across MDGs 3, 4, 5, and 6. Strengthening ecosystems and resource preservation in efforts to counter habitat loss and economic stress, will also help fulfil MDG 7 on sustainable development.

Meanwhile, bringing international resources to bear on the problem, such as programme funding from the highest polluting nations, and further reducing trade barriers to support the most vulnerable communities dealing with climate impacts, would be completely aligned with the spirit of MDG 8 – "Develop a global partnership for development".[213] A programme to disseminate technologies useful for adaptation and emission reductions from highly developed economies to the lowest-income groups would likewise support MDG 8.

Since most of the current impact of climate change affects lower-income or developing countries, many of the programmes assessed in this review are specifically focused on the needs of the most vulnerable groups. But wealthy countries are by no means spared the impacts of climate change, particularly in economic terms, and many of the actions reviewed here are equally pertinent to any given income setting.

THE MILLENNIUM DEVELOPMENT GOALS FOR 2015

GOAL 1	Eradicate extreme poverty and hunger
GOAL 2	Achieve universal primary education
GOAL 3	Promote gender equality and empower women
GOAL 4	Reduce child mortality
GOAL 5	Improve maternal health
GOAL 6	Combat HIV/AIDS, malaria, and other diseases
GOAL 7	Ensure environmental sustainability
GOAL 8	Develop a global partnership for development

"AUTONOMOUS ADAPTATION" OCCURS WHEN FARMERS AND COMMUNITIES AUTOMATICALLY ADJUST TO CLIMATE-RELATED CHANGES

BACKGROUND

The aim of the Adaptation Review is to clarify which actions are known to be both highly effective and readily available to communities seeking to minimize the negative impacts of climate change.

THE METHOD

53 different measures have been reviewed here. These measures were identified through a detailed desk research exercise with the aim of gathering together a broad set of actions and programmes for which there was reasonable information available on cost-effectiveness and other performance indicators. This review includes only those measures for which there were adequate levels of information relating to various aspects of effectiveness, particularly cost-effectiveness. This

information mainly stems from development or specialist literature or National Adaptation Programmes for Actions (NAPAs) and varies in quality from one impact area or measure to another. In some cases, the unsatisfactory levels of information on specific types of actions revealed a major gap in our toolset for measuring the success of adaptation measures and policy-making – a gap that must be addressed if we are to improve our understanding of the climate challenge.

The actions included here are those that relate to the impact areas covered in the Monitor, so they are not comprehensive. Also, certain climate-related impacts, such as permafrost thawing, for example, are not taken into account either here or in the Monitor.

Neither are the actions highlighted here necessarily what would be considered "adaptation policies", since they have only been framed in relation to Monitor impacts and consist of just individual projects in most cases. This catalogue clearly represents just a subset of all possible effective adaptation responses, but it still provides a good indication of the different types of options available.

All measures are rated in terms of their relative effectiveness in reducing a given impact as identified in the Monitor. So, for example, a measure may be rated as beneficial in reducing mortality rates resulting from diarrhea, or in countering lost income due to low agricultural yields in water stressed areas. Beyond cost-effectiveness ("Cost-Effectiveness"), each action has also been reviewed for its co-benefits in supporting other positive changes in society and its ability to equitably benefit wide-ranging groups of people, especially the poor ("Co-Benefits"); for its ability to be easily implemented, bearing in mind uncontrollable risks ("Feasibility"); and for its ability to be easily reproduced in different places ("Scalability"). The assessment methodology we used is explained in more detail in the end matter of this report.

The various action sheets that follow in this section of the report detail each of the measures reviewed. They include information about the effect ("Immediate", "Short-Term", and "Long-Term") that an action will have in terms of reducing impacts. They also detail whether the measure can be rolled out quickly ("Quick Start") or, if not, how long it might take ("Implementation Lapse"). If measures are tied to a programme cycle, such as a school year, the typical timeframe length is also given. Finally, where measures clearly contribute to one or more of the Millennium Development Goals, the specific goal number is a listed under "MDG Boost".

LIMITATIONS AND STRENGTHS

The Review does have clear limitations. For example, most health measures – and several other types of measures – will be significantly cheaper to implement in poorer countries than in highly developed economies. Actions might vary significantly in implementation from one country to another depending on a country's particular situation. For this reason, some implementations could see risks or scalability issues beyond what we have been able to capture in the Review. It is difficult also to compare measures that save human lives to measures that reduce an economic impact within an industry. Nevertheless, each measure does give a fair indication of cost in relation to other types of measures within its own impact area. And The Review makes clear the cost differences between an infrastructure-type response and, say, the promotion of breastfeeding programmes. So interesting insights nevertheless emerge and provide a good indication of the varying options and cost burdens that could apply to a given country depending on its vulnerability profile. Countries should find health impacts, for instance, cheaper in general to combat than desertification or sea-level rise impacts.

Since the Review was organized specifically to verify effectiveness in reducing negative impacts, it has not focused on a number of common adaptation concepts, such as prevention (or the avoidance of harm), adaptive capacity (the ability to deal with change) in the face of long-term climate stresses, or resilience (the ability to recover from a shock) in the face of extreme weather, drought, or other disasters. Nevertheless, the actions assessed here invariably reinforce both adaptive capacity and resilience, such as through coral conservation and re-growth, mangrove planting, or hurricane-resistant housing. They may also help to prevent harm from occurring in the first place through effective flood control, for example.

The Review does, however, have an in-built bias towards concrete practical measures, project-based responses, and infrastructure programmes, since the costs, and sometimes benefits, of such measures are quite clear. Such measures have also largely been the focus of international spending on adaptation and related areas until now.[214]

The Review only takes limited account of external factors that will play a considerable role in the implementation of the actions assessed here, such as underlying governance, legislation, local capacities, policy frameworks, and other factors that will have a critical effect on a country's ability to take adaptation measures. Nor does the Review take into

account financial instruments, such as highly effective private sector strategies of risk transfer through insurance. These are the subjects of numerous other excellent publications of late.[215]

LINKS TO BROADER STRATEGIES

Broader development strategies and policy and legislation responses not captured here also play a critical role in any effective response to the impacts of climate change. For example, the Review only hints at how sustainable governance and management of natural resources such as water, forests, and fisheries are necessary to marine conservation or reforestation programmes.

Diminishing water stocks due, in many cases, to over-extraction or unsustainable usage are just one example of a major natural resource suffering accelerated depletion in areas receiving less rainfall or experiencing more drought as a result of climate change. The impact of climate change on water is also one of the main drivers of economic losses in the Monitor. Rationing or conserving water at the individual or community level such as through rainwater harvesting or micro-irrigation measures mentioned in this Review are examples of how water resources can be better conserved at a grassroots level.

However, bottom-up measures will likely be inadequate if pursued in isolation from top-down policies and efforts. Government intervention through legislation or other policies may be necessary to restrict or manage ongoing extraction or access to water resources in order to avoid total depletion. Ideally, such legislation would in turn encourage wider adoption of the types of water conservation or rationing practices in the Review, which could well become widespread as a result.

REINFORCING PUBLIC SERVICES IS CRITICAL TO A SUCCESSFUL RESPONSE TO THE IMPACTS OF CLIMATE CHANGE

Just as many of the actions in the Review reinforce the MDGs, so too broader human development strategies can play a pivotal role in supporting responses to climate change. Gender development strategies, for instance, have been shown to have a major positive effect on child health – and children are a demographic group heavily impacted by climate change.[216] The creation and maintenance of social safety nets and other non-monetized services that strengthen communities can also reduce vulnerability to climate change.[217]

Many of these types of broader responses rely on adequate governance or robust public services and depend on strong legal systems and institutions capable of implementing and enforcing laws that protect or encourage positive social or individual behavioural changes. In fact, many of the cost-effective actions covered in this Review cannot be implemented in situations with inadequate public services or legal and governance structures. Reinforcing these public services is therefore also critical to a successful response to the impacts of climate change. This also partly explains why so many fragile states are among the most acutely vulnerable to climate change. And for these reasons, communities with both high factors of vulnerability and low human development should be singled out for specific attention.

Salesmen in Congo wade through water at a market in Brazzaville, November 2006. Source: Laudes Martial Mbon/IRIN.

HEALTH IMPACT

There are a variety of measures that can be taken to prevent deaths due to climate change, and many of them are very affordable.[218] Since outbreaks of disease related to climate change are concentrated within certain regions, age groups, and socio-economic groups, good targeting of these diseases is feasible. Life-saving measures to address these health problems are some of the most well-documented and effective measures we have in fighting the negative effects of climate change. Such measures will require financing but could save hundreds of thousands of lives, especially among children and infants.

VERY HIGH
Overall Effectiveness Rating

10 #Actions Assessed

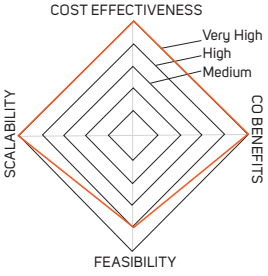
FINDINGS

Around three quarters of the health impacts of climate change involve just three disorders – malnutrition, diarrhea and malaria – and are concentrated in children living in Sub-Saharan African regions and in South Asia.

Only a small fraction of occurrences of these three disorders worldwide are related to climate change. On the one hand, resources of the health, development and humanitarian communities have for decades been put to use to develop highly effective responses to these diseases.[219] Indeed, much of this section of the report is based on the expansive Disease Control Priorities in Developing Countries project, which in its second global edition has brought together large volumes of research from hundreds of experts and organizations active around the world.[220] On the other hand, measures addressing those same diseases – such as the simple mixture of sugar, salt, and clean water used to rehydrate people suffering from diarrhea – are so cost-effective that these diseases almost never lead to death in wealthy countries.

It is the poor that fall victim to deadly but preventable diseases. Whatever measures and programmes are employed to tackle these health problems must support the poorest of the poor, and external resources must support that effort.[221] Indeed, expanded efforts to deal with these diseases in recent years have reduced their frequency.[222] The loss of millions of lives every single year is linked to an ongoing shortfall of support. Climate change is projected to further encumber efforts to tackle these major illnesses. So it is all the more crucial that we step up campaigns to address maternal and child health, particularly in the areas of malnutrition, diarrhea and malaria. Such campaigns are critical to preventing reversals, for example, reoccurrences of malaria outbreaks in areas where the international community has already committed to achieving eradication. Yet health interventions are currently quite underrepresented in national climate-change adaptation action plans.[223]

REVIEW FINDINGS



THE REVIEW

All the health measures assessed in this report registered high levels of effectiveness in limiting the negative effects of climate on health.

For each health concern there is a corresponding array of immediate, medium- and long-term measures that are effective for various age groups and for various urban and rural settings.

All of the health-related interventions included in this report are cost-effective, and several are highly cost-effective, requiring less than USD 500 to prevent one year's ill health (which the health community refers to as Disability Adjusted Life Years).

In almost every case, the measures that could be taken to reduce health problems also have clear socio-economic benefits or other advantages. For instance, in-school feeding programmes also yield educational advantages, and improved water and sanitation facilities help foster wider economic activities.[224]

There is generally a highly comprehensive body of accumulated evidence and empirical and case-study research available to rate the effectiveness of various health measures and to support decisions on how to go about implementing those measures. Guidelines and training programmes are also readily available for all measures suitable to the worst-affected populations, which include lowest-income and conflict-stricken communities as well as communities experiencing emergency situations. In cases where rising temperatures are enabling diseases like malaria and dengue fever to spread to populations in higher altitudes, for instance, existing measures (such as the distribution of insecticide-treated bed nets) can be implemented in the newly effected zones.

The factor most likely to hinder implementation of specific measures to combat climate-change related health problems is feasibility. Improving water supplies is possible, for example, only if a reliable source of water is available. And a range of factors – among them climate change itself – make finding reliable water sources increasingly difficult.[225] Similarly, construction and maintenance of adequate sanitation facilities in rural or island communities require local expertise and resources that are not always on hand.[226]

TIMEFRAME CONCERNS

A phased approach is critical to effectively addressing the health impacts of climate change, and rolling back the burden of climate-sensitive diseases in general, as is the international community's established goal.

A number of measures can have an almost immediate effect and, in some instances, can reliably avert death in the large majority of cases. Bed nets and in-door insecticide spraying, for example, offer immediate protection for families located in malaria-endemic areas by keeping disease-carrying mosquitoes away.[227] Oral rehydration therapies, such as use of water-based sugar-salt solutions, can prevent death and help patients recover from dehydration.[228] None of these interventions permanently reverses the course of disease.

Some illnesses can be tackled at the root of their cause. For instance, Rotavirus A, which causes 90% of infectious diarrhea cases, is passed from person to person via contaminated faecal particles introduced into the body via the mouth.[229] Improved water and sanitation facilities limit transmission of the disease. Immunization can also help prevent the virus from making children sick.

Almost all health measures included in this report fall into the immediate or short-term (impact within one year) categories. Excessive heat notification and response systems, for example, will really only have an effect when a heat wave occurs.[230]

IN ALMOST EVERY CASE, THE MEASURES THAT COULD BE TAKEN TO REDUCE HEALTH PROBLEMS ALSO HAVE CLEAR SOCIO-ECONOMIC BENEFITS OR OTHER ADVANTAGES

HEALTH IMPACT **ADAPTATION ACTIONS**

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
1	CHILD SURVIVAL PROGRAMME WITH NUTRITION COMPONENT	• Malnutrition		Very High	Medium
2	SCHOOL HEALTH AND NUTRITION PROGRAMMES	• Malnutrition		Very High	High
3	BREASTFEEDING PROMOTION	• Diarrhea • Malnutrition		High	High
4	ORAL REHYDRATION THERAPY AND ZINC SUPPLEMENTATION	• Diarrhea		Very High	High
5	IMMUNIZATION PROGRAMMES (ROTAVIRUS, HIB, HEPATITIS B, PNEUMOCOCCAL)	• Diarrhea • Acute respiratory infections		High	High
6	IMPROVED WATER SUPPLY INFRASTRUCTURE	• Diarrhea		Very High	Medium
7	BASIC SANITATION FACILITIES	• Diarrhea • Waterborne diseases		Very High	High
8	INSECTICIDE-TREATED BED NETS	• Malaria • Dengue, other vector-borne diseases		Very High	High
9	INDOOR RESIDUAL SPRAYING	• Malaria		Very High	High
10	EXCESSIVE HEAT EVENT NOTIFICATION AND RESPONSE PROGRAMMES	• Cardiovascular and respiratory diseases		High	High

Infants Children Adolescents Adults Elderly Population in poor health

Very low Low Medium High Very high

CHILD SURVIVAL PROGRAMME WITH NUTRITION COMPONENT

1

Community-based nutrition programmes to prevent stunted growth, control disease, and improve survival. Such programmes promote breastfeeding, provide education, and offer counselling on how best to feed children, prevent diarrheal disease, and monitor growth.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 1 year

Expense: $2 (less intensive) - $10 (more intensive) per child

Impacts Addressed: **Child health, malnutrition**

Child survival programmes rate highly on scalability, cost-effectiveness, and co-benefits. At $42 per DALY, this programme is among the least expensive of all health programmes assessed here. Improving child health can result in a number of other positive socio-economic benefits. Excellent guidelines and simple, effective training are readily available to help expand this programme to new areas. The programme is also particularly suited to low-income communities vulnerable to malnutrition, since that is a problem it specifically targets.

The programme received a low rating for feasibility, mainly because, in some cases, children take the nutrition supplements and food home to adults rather than consume them themselves. The programme has only a moderate base of evidence for its effectiveness. Additional research and peer-reviewed studies would help more accurately establish the programme's value.

The programme has very quick effects. In highly vulnerable communities, we see the effect well within one year of implementation. That effect continues for the length of the programme cycle, typically one year of duration, and can have benefits beyond that due to its educational component.

MDG BOOST ↑1, ↑4, ↑5

Sources: DCPP

SCHOOL HEALTH AND NUTRITION PROGRAMMES

2

Simple school-based programmes to improve health through low-cost interventions such as treatment for intestinal worms and schistosomiasis; prompt recognition and treatment of malaria; distribution of insecticide-treated bed nets, micronutrient supplements, meals, snacks, and first-aid kits; and referrals of children to youth-friendly clinics and associated programmes.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Very High	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 1 year

Expense: $37 per DALY

Impacts Addressed: **Child health, malnutrition**

School health and nutrition programmes rate highly on cost-effectiveness ($37 per DALY), co-benefits, feasibility, and scalability. This programme is among the least expensive of all health measures assessed here. Improving child health can also lead to better educational results. Such programmes can roll out quickly using existing educational networks and have an especially high impact on the poorest and most undernourished children.

Evidence shows that the number of children reaching school age (defined as 5 to 14 years of age) is increasing due to such child survival programs. In The Gambia, girls were more than twice as likely to enroll in primary school if they had received malaria prophylaxis in early childhood. In Kenya, treatment of Helminth infections reduced absenteeism by one-fourth, with the youngest children (who typically suffer the most ill health) showing the largest gains.

The evidence base for the programme is high -- we have several well-documented examples from various geographical regions. However, not all types of intervention are relevant to all situations or locations, so it is essential to assess the needs of a community prior to each implementation.

The programme's positive impact is consistent only as long as the children continue to attend school. Positive impacts can have an almost immediate effect, since the programme rolls out through existing networks. The programme's effectiveness ends as soon as the programme does.

MDG BOOST ↑1, ↑3, ↑4, ↑5, ↑6

Sources: DCPP

BREASTFEEDING PROMOTION

3

Encouraging new mothers to breastfeed their infants for the first six months of life. Breastfed infants should receive no other food or drink, including water, except for supplements of vitamins and minerals and necessary medicines.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 1-2 years

Expense: $0.46-$17.50 per child

Impacts Addressed: **Diarrheal disease**

Breastfeeding-promotion programmes rate highly on scalability, co-benefits, and cost-effectiveness ($930 per DALY). Technical specifications and guidelines for implementing this programme already exist, and global training programmes are well developed and accessible. Promoting increased breastfeeding can result in other health benefits. Exclusive breastfeeding eliminates the intake of potentially contaminated food and water. Breastfeeding also significantly lowers the risk of transmitting infections to children and reduces child mortality rates, especially among the poorest groups. Breastfeeding promotion is among the least costly actions available to the health community today.

The programme has a large base of evidence for its effectiveness. Various empirical studies and economic analyses have been carried out in multiple countries. Studies have shown that in developing countries, breastfed children under six months of age are 6.1 times less likely to die of diarrhea than infants who are not breastfed.

The programme ranks low on feasibility because it relies heavily on behavioural change. For example, it is possible to promote breastfeeding through community-based mothers' support groups, but few such support groups exist, and where they do, their members tend to be women who are already motivated to breastfeed. There is also some danger in promoting exclusive breastfeeding in HIV-affected communities, since there is some risk of transmitting infection to the infant.

MDG BOOST ↑1, ↑4, ↑5

Sources: DCPP

ORAL REHYDRATION THERAPY AND ZINC SUPPLEMENTATION

4

A simple water, sugar, and salt (or similar) solution and a zinc nutrient supplement provided as a drink to patients to prevent dehydration and chronic diarrhea.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Medium				
FEASIBILITY	Very High	Short-Term	✗	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 1 year

Expense: $0.02-$11.00 per person

Impacts Addressed: **Diarrheal disease**

Oral rehydration programmes rate highly in feasibility, scalability, and cost-effectiveness. The programme received a high rating for cost-effectiveness, since it is instantly implementable and requires little management, although the cost per treatment can vary widely (from $73- $1,062 per DALY) depending on how the solution is prepared and administered.

The programme has a high feasibility rating due to its high success rate across a variety of contexts, its ease of implementation, and its consistent results. The programme has a high base of evidence for its effectiveness. It is a widely applied tool that has been broadly used for many decades. Its success has been well documented through various studies from WHO and The Disease Control Priorities Project. Also, since rehydration solutions are simple, readily available, and universally applicable, the programme can scale up very easily.

The programme rates low on co-benefits, mostly because its core focus is to avert death due to dehydration, the main cause of fatality in cases of diarrhea.

The programme can be put into operation instantly to avert almost imminent death. However, it does nothing to reduce the problem of infectious diarrhea.

MDG BOOST ↑1, ↑4

Sources: DCPP, Jamison et al. (2006)

IMMUNIZATION PROGRAMMES

5

Rotavirus vaccination to prevent the most common cause of infectious diarrhea, and/or Haemophilus influenzae type B (Hib) vaccination to prevent pneumonia and meningitis.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 1-3 years

Expense: $17 on average per fully immunized child

Impacts Addressed: **Diarrhea (rotavirus), acute respiratory infections (pneumonia)**

Immunization programmes (including Hib and Hepatitis B) rate highly on cost-effectiveness ($296-$2,478 per DALY) and scalability. In Chile, the government determined that the creation of a combined diphtheria-tetanus-pertussis and Hib vaccine was worthwhile and that the vaccine could be delivered as part of an already well-functioning system of routine immunization.

WHO has already established a standard immunization schedule, and a number of countries operate large-scale, sustainable training programmes at the community level. However, affordable medical care is generally lacking, and inadequate clinical conditions may result in less effective vaccine treatments. Additionally, rural populations may be excluded from treatment due to the difficulties of distributing vaccines to remote areas.

While the evidence base is high, additional research and peer-reviewed studies would help more accurately establish the effectiveness of vaccination programmes. The long-term consequences and co-benefits of vaccinating against diarrheal diseases remain poorly studied. Additionally, investments in R&D are required before large-scale rollout of a rotavirus vaccine programme can be considered.

Immunization has a close to immediate effect protecting against infection and transmission but cannot eliminate an existing infection or fatality risk.

MDG BOOST ↑4, ↑6

Sources: DCPP

IMPROVED WATER SUPPLY INFRASTRUCTURE

6

Installation of hand water pump, standpost, or house connection in areas where clean water supply is limited and no plumbing infrastructure exists.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 1-3 years

Expense: $17 (borehole) - $144 (house connection) per person

Impacts Addressed: **Drinking water, diarrheal disease**

Improved water supply infrastructure programmes rate particularly highly on co-benefits and cost-effectiveness ($159 per DALY). Dozens of viruses, bacteria, protozoa, and helminths cause diarrheal and other diseases. They are generally picked up through fecal-oral transmission, often by drinking contaminated water or eating unwashed foods in areas lacking a clean water supply.

The programme's costs are consistently low, although they may differ in urban and rural environments. The programme improves living conditions and prevents a wide range of contaminants from entering the body. It also has various indirect effects, including time saving (an Indian national survey for UNICEF found that women spent an average of 2.2 hours per day collecting water) and nutritional benefits (if poor households spend less money on water, they will have more funds for food).

The programme rates lowest on feasibility, since it demands ongoing investment and cannot succeed in areas where water is in very short supply. However, the programme has shown that, once implemented, it delivers consistent results. Technical specifications and guidelines are extensively available and fully tested, and many good case examples exist of the programme's success in low-income communities.

Installation is quick, and its effect on halting the spread of disease and bacteria due to unclean water and food is virtually immediate. If the infrastructure is maintained, the programme yields long-term benefits.

MDG BOOST ↑2, ↑3, ↑4, ↑6

Sources: DCPP, Jamison et al. (2006)

BASIC SANITATION FACILITIES

7

Construction and promotion of basic sanitation where sanitation facilities are limited.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 0-2 months
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $60-$160 per person

Impacts Addressed: **Diarrheal disease**

Basic sanitation facilities programmes rate highly on cost-effectiveness, co-benefits, and scalability. At a construction cost of $60 per capita for basic sanitation facilities and a lifetime of 5+ years for a latrine, this programme remains among the least expensive of the health measures assessed here. Lower-cost models are possible in areas that lack infrastructure or where more complex sanitation systems are not feasible, making such a programme highly cost-effective even where construction costs are high.

The programme is beneficial to all groups in a community lacking sanitation and reduces the spread of diarrhea while also producing socio-economic and cultural benefits. However, it is unclear whether we can attribute the positive effects to the installation of latrines alone, since benefits have only been measured in combination with improved hand-washing habits. Benefits are highest where a clean water supply is also available.

WHO, UNICEF, and the World Bank have already developed technical specifications and guidelines for low-cost sanitation projects, and many well-documented case examples exist. However, there is a lack of training in appropriate construction techniques.

Successful implementation also depends on behavioural changes. Some studies indicate that, to reap the full impact of the programme, communities must make cultural adjustments over time.

Implementation can occur quickly depending on the solution chosen. Benefits accrue immediately thereafter and, with well-maintained infrastructure, last long-term.

MDG BOOST ↑4, ↑6, ↑7

Sources: DCPP, Jamison et al. (2006)

INSECTICIDE-TREATED BED NETS

8

Treatment of purchased or subsidized bed nets with insecticides.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 per bed net

Impacts Addressed: **Malaria**

Bed nets rate very highly on cost-effectiveness ($5-17 per DALY) and co-benefits. Use of insecticide-treated bed nets provides personal protection by killing or repelling mosquitoes and is a very effective strategy for controlling malaria. This action is among the least expensive of all known health measures. Bed nets are easy to distribute through subsidies or other programmes, and costs are consistent in Sub-Saharan Africa (the area where malaria is most prevalent). The programme is applicable and relevant to all groups in a community.

Recent cross-country comparisons of economic growth indicate that eliminating malaria can have a strong positive impact on economic development. Currently, bed nets must be treated semi-annually; however, new technology should eliminate this requirement. When bed net users receive basic training in how to use the net, the programme's success rate is high. Protection is only during sleeping hours, but that is a high-risk period, which is why over 20 studies in Africa and Asia have demonstrated a protective success rate of over 50 percent for individual net users.

Training programmes should be culturally sensitive and adapted to local customs. More operational experience is necessary before it is possible to inform national initiatives on how to scale up use. Bed nets function immediately, can be distributed extremely quickly, and the latest models have a lasting effect for many years if well maintained (in particular through the repair of holes).

MDG BOOST ↑4, ↑5, ↑6

Sources: DCPP, Jamison et al. (2006), WHO (2006)

INDOOR RESIDUAL SPRAYING

9

Applying long-lasting insecticides to the walls and surfaces of dwellings.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 0.5 year

Expense: $9-$24 per treatment

Impacts Addressed: **Malaria**

Indoor residual spraying programmes rate highly in co-benefits, scalability, and cost-effectiveness ($32 per DALY). Recent cross-country comparisons of economic growth indicate that eliminating malaria – which residual spraying directly addresses – has a strong positive impact on economic development. A 10 percent reduction in malaria has been associated with 0.3 percent higher economic growth per year.

Technical specifications, guidelines, and several training programmes on applying the insecticides are already available, including Roll Back Malaria and WHO implementation programmes.

Indoor insecticide spraying has a consistent impact where it can be applied, although frequent applications are necessary.

Effectiveness will depend on the length of the malaria-transmission seasons and on the insecticide used. The programme has been evaluated by several WHO studies in Africa, the Americas, Asia, and Europe and by empirically based, well-documented assessments. The cost to implement such a programme may be out of reach for many low-income countries, and successful implementation can require extensive planning, coordination, infrastructure, and skills and high coverage levels. Communities may also develop environmental problems due to the toxicity of the insecticide.

The effect of a spraying programme is instantaneous, but most insecticides are effective for just 2-6 months, requiring constant reapplication.

MDG BOOST ↑4, ↑5, ↑6

Sources: DCPP, WHO (2006), Jamison et al. (2006)

EXCESSIVE HEAT EVENT NOTIFICATION AND RESPONSE

10

Programmes combining meteorological forecasts and other data to trigger public health interventions to reduce heat-wave illnesses and deaths.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 6 months
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 2-5 years

Expense: $200,000

Impacts Addressed: **Cardiovascular and respiratory diseases**

Excessive heat event notification and response programmes rate highest on co-benefits. The programme can be cost-effective and easily implemented where advanced public health and meteorological systems are in place, which is the case for many of the worst affected areas, such as Europe and North America.

The programme demands reliable meteorological data and established communication channels that may not always be available or adequate in low-income settings, particularly in remote communities. It is also difficult to guarantee that communications will reach the appropriate groups/persons. While clear technical specifications and guidelines exist, the programme has lower relevance for low-income countries, since heat waves cause most damage in regions where extremely hot weather is relatively infrequent. Local coping methods are already common in areas that regularly experience high heat, such as many low-income countries in Africa and Asia.

Several peer-reviewed studies exist on the subject. However, there is no standard way to estimate the impact in different countries. It can take weeks to more than a year to implement such a system. Once established, such programmes are easily maintained into the long-term, provided supportive public and other services are also functioning.

MDG BOOST ↑4, ↑5

Sources: Kovats & Ebi (2006), U.S. Environmental Protection Agency (2006), Ebi et al. (2004)

Bush fire close to the Italian city of Genoa in September 2009. Source: Wikimedia Commons/Janurah.

WEATHER DISASTERS

Weather disasters can occur anywhere a major storm, flood, or wildfire has hit in living memory. Extreme heat, wind, rain, and flooding are cutting new paths of impact.[231] But not everyone is at risk – far from it. Exposure to major floods, storms, and fires tends to be localized and specific. The worst disasters can cost nearly a decade's worth of global loss of life and damage and can wipe out close to half of an economy.[232] Measures taken in advance to help minimize these impacts are not always cheap. Emergency response measures carried out after the fact are usually far more expensive and will never restore the lives lost that could have been prevented with advance action.[233]

HIGH
Overall Effectiveness Rating

11 #Actions Assessed

FINDINGS

Countries vulnerable to more intense weather and fires are an eclectic group. Island paradises such as Belize join ranks with failed states such as Somalia. Coastal nations such as Cuba, Micronesia, Yemen and the Philippines experience similar scales of impacts as landlocked Mongolia or mountainous Bhutan and Boliva.[234]

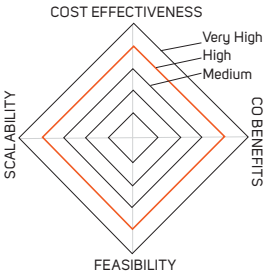
In many cases, even for the most exposed countries, disasters are far from common. For the majority of countries, major disasters occur more on the order of once a decade.

While a disaster, by definition, takes the affected community by surprise, few floods, fires, or cyclones occur in places that have been hitherto untouched by natural disasters, despite the fact that extreme weather is spreading beyond its traditional paths. Unusually strong and unexpected floods or storms can run against prior experience, such as Cyclone Nargis, which devastated Myanmar in May 2008.

Some communities accept risks more or less consciously. The United States' 1938 New England hurricane wiped out tens of thousands of homes and maimed hundreds with its powerful storm surge on Long Island in New York.[235] Today, the affluent West and South Hampton beaches of the area are lined with new homes and buildings, seemingly oblivious to the power of nature.[236]

What overwhelms communities is the breaching of a new threshold. The New Orleans levees breached by Hurricane Katrina,

REVIEW FINDINGS



THE INTERNATIONAL DONOR COMMUNITY IS MORE INCLINED TO PROVIDE FINANCIAL SUPPORT TO A COMMUNITY IN THE WAKE OF A DISASTER RATHER THAN TO PREVENT AS DISASTER FROM OCCURRING IN THE FIRST PLACE

for example, would have been made more robust if they had been expected to withstand more extreme weather than the region had experienced in the past. Since the parameters for climate-caused disasters are shifting, we must regularly challenge the false security of proven, or previously sound, adaptation.[237]

While some communities accept such risks, others simply lack the means to take measures to improve safety. An unfunded USD 2 million emergency flood warning system in Laos, for example, that would be capable of protecting many families from mass inundations, ranks number 7 in the nation's list of climate-change adaptation priorities. Floods of that sort could occur tomorrow or in 10 or 30 years time. In the case of Laos, floods leave nearly half a million people in need of emergency assistance every few years.[238]

The worst natural disasters in modern history occurred when the giant rivers of China, without warning, swamped the plains along the Yangtze or Yellow River, one of the most densely populated areas in the world.[239] But no disaster of that scale – killing millions and destroying the wealth of large populations – has been witnessed since. Communities have learned to protect themselves against the worst natural disasters.

Today, disaster risk reduction – steps to reduce the impacts of possible environmental catastrophes – is a well-developed field. So while the risks of extreme weather are expected to increase, we know where the most acute vulnerabilities lie, and measures exist to reduce risks and exposure to populations and their economies.[240]

Measures must be taken to avoid the worst tragedies. Disaster prevention still fails to mobilize adequate resources among the international donor community, which is more inclined to provide financial support to a community in the wake of a disaster rather than to prevent a disaster from occurring in the first place.[241] No measure of assistance after a disaster will restore lives lost in a large-scale disaster. The catalogue of possible actions provided in this chapter highlights how much more retroactive measures cost compared to proactive ones.

WHAT OVERWHELMS COMMUNITIES IS THE BREACHING OF A NEW THRESHOLD

Flooding in Pakistan. Source: UN Photo/WFP/Amjad Jamal.

THE REVIEW

Options for reducing the severity of weather-related disasters vary significantly in feasibility, cost-effectiveness, and expense. Most actions not only reduce our vulnerability to key climate risks but also help to reduce disaster risk overall.

Some of the most expensive alternatives, such as flood buffers and levees, can require millions of dollars of investment. Other alternatives, such as mangrove-planting and education campaigns, are relatively affordable although still clearly more expensive than most interventions we've looked at (in the health category, for example).[242]

The majority of possible measures provide no guarantee of reduced impacts, since sea or river walls are only ever as powerful as their weakest link.[243] Early warning systems may function perfectly, but a void in awareness of risks could result in millions in need of humanitarian assistance if precautionary guidelines are not adhered to.[244]

Nearly every available option has clear benefits beyond lessening the impacts of climate change. Enhanced weather forecasting to better anticipate storms and floods, for example, will also improve information to key industries, such as agriculture, energy, and transport.[245] Such measures will also help a community rebound from a catastrophe. For example, raised roads built with proper drainage and raised high enough to preserve their composition will allow for emergency assistance to be delivered where needed and will also enable the local economy to get its key trade nodes operational quickly after a crisis.[246]

Mangroves not only slow the wind speed of tropical cyclones. They also sequester carbon from the atmosphere, preserve biodiversity in wetland areas, and reduce the impact of sea-level rise on coastal environments. Mangroves also serve as natural flood barriers, since their roots reclaim sediment that might otherwise flow into rivers and cause flooding.[247]

Coastal barriers can play a major role in preventing the worst effects of sea-level rise and holding back storm surges. The more than USD 60 million sea wall enclosing the Maldivian capital of Male' proved crucial to its survival of the 2004 Indian Ocean tsunami.[248] In the long-term, however, sea walls can also be detrimental to the local environment by trapping saltwater inland and gradually reducing the fertility of adjacent soils through salination.[249]

The most expensive way to reduce the impacts of weather-related disasters, almost invariably, is providing emergency assistance to populations following a disaster. Here, costs may rise into the tens or hundreds of millions of dollars depending on the number of people in need of help. So investing before disasters occur should be the focus of any adaptation strategy focused on extreme weather.[250]

Lives are easier to save than infrastructure, and buildings can be reconstructed, where lives can never replaced. It is critical that any adaptation strategy ensure first and foremost the protection of highly vulnerable civilian populations.

Proactive measures for countering weather-related disasters are generally well documented, although no cost-effective measures relating to wildfires are included in the assessment. Most measures can be applied universally and can benefit all income groups.

TIMEFRAME CONCERNS

Reducing the impacts of extreme weather is going to require major strategic decisions. Some actions, like storm shelters or ensuring emergency evacuation procedures, are easily taught and followed and can offer protection in the relatively near term.[251] Other much more expensive multimillion-dollar disaster monitoring systems may be harder and costlier to implement and maintain but could save hundreds of thousands of lives.

Sea walls or riparian river buffers vary from simple, often weak mud flood levees to giant, kilometre-long concrete barrier systems. Such measures can take anywhere from a few days to several years to construct, and budgets range correspondingly from a few dollars to tens of millions.[252]

There is a need, therefore, to balance the choice of policies so that new measures can be implemented quickly in the most vulnerable communities, while more intensive, high-investment but high-return actions are implemented in parallel.

WEATHER DISASTERS **ADAPTATION ACTIONS**

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
1	COMMUNITY-BASED LOCAL EARLY WARNING SYSTEMS	• Injuries • Loss of shelter and livelihoods		High	High
2	FORECASTING SYSTEMS	• Injuries • Loss of shelter and livelihoods		High	High
3	DISASTER-MANAGEMENT TRAINING PROGRAMMES (PREPAREDNESS)	• Immediate impact of extreme weather events		Very High	High
4	DISASTER RELIEF (LIMITED CARE)	• Injuries • Loss of shelter and livelihoods		High	High
5	FLOOD PROOFING OF HOUSES	• Physical damage due to floods		High	Low
6	FLOOD PROOFING OF ROADS	• Storms, floods		High	Medium
7	RIPARIAN BUFFERS	• Floods		High	Medium
8	MANGROVE PLANTING	• Floods		Medium	Medium
9	HURRICANE-RESISTANT HOUSING/SHELTERS	• Injuries, death • Physical damage due to hurricanes		Medium	High
10	FLOOD CONTROL	• Floods		High	High
11	PRE-POSITIONING OF ESSENTIAL ASSETS (COMMUNITY-BASED PREPAREDNESS)	• Human health		Very High	High

Children · General population · Elderly · Low-income populations · Urban populations · Livelihoods derived from fisheries and cash crops · Populations close to rivers · Populations close to coasts

COMMUNITY-BASED LOCAL EARLY WARNING SYSTEMS

1

Creating a system for communities to get knowledge of potential disasters before they happen and to disseminate warnings via local warning communication chains.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 6 months
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 1 Year

Expense: $1 million+ per system

Impacts Addressed: **Injuries, loss of shelter and livelihoods, damage to property**

Early warning system programmes rate highly on co-benefits. The system would benefit all groups in the focus area. The early warning system is cost-beneficial within one year if the local community is trained to react to early warnings and if monitoring infrastructure is properly maintained. Implementations will vary depending on weather patterns, location, and risk addressed, and must be complemented by appropriate capacity building in communities at risk, training of professional emergency services, and adequate resources to support preparedness and effective response.

The warning system is highly dependent on the local community's willingness to cooperate and act, and there must be adequate technical expertise on hand to maintain local weather stations and report data. The UN has developed guiding principles for such systems, and many training programmes are available.

The programme has high relevance for low-income countries, since more than 90 percent of natural disaster-related deaths occur in these countries. The interest for establishing local and low-cost early warning systems is growing, according to the German Technical Cooperation.

MDG BOOST ↑1

Sources: IFRC (2009), IFRC (2004), GTZ (2009), UN (2006), Plummer et al. (2003), WMO

FORECASTING SYSTEMS

2

Involves technical monitoring of larger-scale weather systems, climate modelling and warning services, and communication of warnings.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 6 months
SCALABILITY	High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 1 year

Expense: $1 million+ per system

Impacts Addressed: **Injuries, loss of shelter and livelihoods, damage to property**

Forecast systems rate highly on co-benefits and can be considered cost effective. They inform local communities about potential weather disasters and are also beneficial to agricultural production and other sectors of the economy, resulting in improved quality of life. The systems benefit all groups in the focus area. However, due to differences in weather patterns and available technological services and funding, some communities will experience easier implementation and higher success rates than others.

The forecast systems can be considered cost-beneficial after approximately 8.5 years. However, as they become more efficient and less expensive, their overall cost-effectiveness should improve over time. The World Meteorological Organization coordinates more than 150 national, 35 regional, and 3 global meteorological centres that analyze data in near real-time to make forecasts and issue hazard warnings.

Forecast systems must be complemented by capacity building and a trained local community force (cf. Community-Based Early Warning). The programme will continue to be effective for as long as the systems are maintained.

MDG BOOST ↑1

Sources: IFRC (2009), UNISDR (2007), UNISDR (2005-2015), GTZ (2009)

DISASTER MANAGEMENT TRAINING PROGRAMMES (PREPAREDNESS) 3

Disaster preparedness is primarily a matter of building adequate shelter and human resources (not necessarily investing heavily in advanced technology and equipment).

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✓	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 1 year

Expense: $25,000-$100,000/programme

Impacts Addressed: **Immediate impact of extreme weather events**

Disaster preparedness programmes benefit all groups in the focus area, in addition to protecting and informing agriculture and other productive sectors important to a community's economy and well-being. Preparing populations for natural disasters is often under-prioritized in low-income countries due to a lack of funding.

Building adequate local shelter is one of the most cost-effective ways to improve the quality of national response and external aid in extreme weather events. The programme is quick to implement where educational facilities exist. And it is more cost-efficient to have trained personnel on the ground instead of relying on international aid.

The programme has wide implications for those affected by natural hazards and on how resources are allocated in emergency situations. Regarding the programme's feasibility, international training should be adapted to local conditions. If training and emergency preparedness is coordinated with relevant UN agencies and NGOs, programme results will be consistent. Thorough guidelines exist, and several NGOs and universities have developed training programmes. For example, Columbia University's School of Public Health has an online training centre that offers a variety of courses, tools, and other resources.

MDG BOOST ↑1

Sources: Columbia University (2010), DCP2 (2006), UNISDR (2007)

DISASTER RELIEF (LIMITED CARE)

4

Limited medical care in case of disaster. Includes treatment for infection and minor trauma. Also includes diagnosis, advice, pain relief, and treatment (as resources permit) for more complicated conditions.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	✗
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 1 year

Expense: $25,000-$1,000,000 or more; per DALY: $253-$380 (low-income countries), $507-$760 (middle-income countries)

Impacts Addressed: **Personal injuries and disability**

Limited-care disaster relief programmes rate highly on cost-effectiveness because of their short- to medium-term duration. However, there is a risk of low cost-effectiveness in the cases where inappropriate in-kind donations are made. And bringing in outside health professionals can be less cost-effective than using local services.

Since the programme focuses on personal, limited care, co-benefits are low. However, in the case of natural disasters, medical care is relevant to all groups.

Emergency response efforts usually take place in a politically and emotionally charged climate. Often, the international community launches its own relief operations in the belief that local health services are incapable of handling the disaster. However, local health services are actually best situated to respond to health consequences of disasters in their communities.

WHO guidelines exist on a variety of disasters, and NGO training programmes are common. The programme is highly relevant, since low-income countries are more likely to experience a drop in GDP due to disasters. The World Bank, Red Cross, and WHO have published various peer-reviewed studies on the subject. And risk-management programmes are common in the Ministries of Health in low-income countries.

MDG BOOST ↑1, ↑6

Sources: DCP2, UNFCCC, NAPA Cambodia (2007)

FLOOD PROOFING OF HOUSES

5

Flood proofing of individual houses against the maximum flood level recorded in the past 20 years.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 2-3 years
SCALABILITY	Very High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 25 years

Expense: $144-244 per house

Impacts Addressed: **Physical damage due to floods, human health**

Programmes to promote the flood proofing of houses rate highly on co-benefits and scalability. Livelihoods and houses are improved and protected as a result of the programme. It is highly relevant to vulnerable groups in low-income countries and promotes consistent benefits for all households. Many UNFCCC and other case examples are available on the subject.

A flood-proofing programme is funded and rolled out over several years and can take 25 years to fully implement. However, it is relatively cost-effective over time, and after four years, the benefits exceed the costs. Also, results are consistent as long as the implementation is designed to fit local needs. If the programme is established correctly, results are consistent.

Policymakers currently show little interest in the programme, and peer-reviewed studies on the subject are limited. However, such programmes have been common in Bangladesh, where flood proofing by way of raising houses and other infrastructure is part of traditional practice. A house raising option programme in Bangladesh's main river char lands will provide raised households to some 2.5 million people.

MDG BOOST ↑1, ↑7

Sources: UNISDR (2007), Islam & Mechler (2007), Caspari & Pokhrel (2008)

FLOOD PROOFING OF ROADS

6

Flood proofing of roads and highways by raising road height to the highest recorded flood and providing adequate cross-drainage facilities.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically after 2-3 years
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Varies

Expense: $100,000-$200,000 per km of road

Impacts Addressed: **Flooding**

Programmes to flood proof roads rate highly on co-benefits. Benefits of the programme include preventing human and livestock deaths, using of the raised roads as refuges during floods, and providing a corridor for transporting relief goods during floods. Once a raised roads programme is implemented, resources can then be allocated to other flood-prone areas, and transportation will not be obstructed due to collapsed roads. The programme benefits all groups. Results are consistent as long as road standards are high.

Raising roads is a long-term programme implemented over stages and is only cost-effective in high-risk areas, where flooding is frequent. However, compared to the cost of full rehabilitation of roads ($70,000 per km), the programme (approximately $140,000 per km) is cost-effective over time.

Implementation requires funding and occurs over several years. However, it entails low risk, and results are consistent if the programme is established correctly. It is important to note that raised roads without proper drainage and careful planning could submerge poor households that do not have the capability or incentive to build up their own land.

In Bangladesh, approximately 170 km of national and regional roads and 518 km of local roads in high-risk areas will be raised. Since it is a long-term programme with very high costs, portions of roads will be raised when they are due for major maintenance, with priority given to high-risk areas.

There is a lack of well-documented training sources and case examples for this programme. However, comprehensive technical specifications and guidelines are available, and technical capacity often exists at the local level. The programme is highly relevant in low-income countries where roads already exist.

MDG BOOST ↑1, ↑7

Sources: UNISDR (2007), Islam & Mechler (2007), UNESCO (2009), IDS (2007), Caspari & Pokhrel (2008)

RIPARIAN BUFFERS

7

By impeding and absorbing flood waters, riparian forest buffers reduce flood damage. Riparian buffers also lower flood frequency because they reduce the amount of sediment flowing into rivers and streams that can make them prone to overflowing.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically after 2-3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Varies, depending on technique used

Expense: $1,000,000+

Impacts Addressed: **Flooding, water quality**

Riparian buffer programmes rate highly on co-benefits, since they also protect water supplies and prevent widespread source pollution, benefiting all groups.

The programme received a lower rating for cost-effectiveness because some barriers (tree plantation vs. grass, for example) can take a long time to develop and can involve high tending costs. However, in the Feitsui reservoir watershed in Taiwan, there is a 1.245 benefit-cost ratio after a period of three years.

MDG BOOST ↑1, ↑4, ↑6, ↑7

Sources: UNISDR (2007), Chang et al. (2010), Caspari & Pokhrel (2008)

MANGROVE PLANTING

8

Mangroves can serve as buffer zones in front of sea dike systems, reducing water velocity, wave strength, and wind energy.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 10 years

Expense: starts at $225 per hectare

Impacts Addressed: **Floods, storms, tsunami**

Mangrove-planting programmes rate highest on co-benefits and scalability. Planting mangroves in their native habitat restores coastal biodiversity (including fish and shellfish production), enhances water quality, and can protect homes, agriculture, and livestock from flooding.

The FAO and various NGOs have developed guiding principles for this kind of programme. The programme is highly relevant for coastal communities in low-income countries, which are most vulnerable to natural disasters. Various NGOs have developed training programmes and materials, but they are not always accessible.

The programme received a low rating for cost-effectiveness because, although restoration pricing varies, it can be high in some regions. Also, the full effects of restoration are felt only in the medium- or long-term. In Vietnam, $1 million was spent to replant 110 kilometres of mangrove forest. As a result, dyke maintenance costs have been reduced by $7 million per year.

In a number of cases, mangrove-planting programmes have reported low survival rates of plants. Once fully restored, however, mangroves are consistently effective against storm surges. Various peer-reviewed studies on the subject are available; however, they lack quantitative data and evidence of cost-effectiveness. There is also a lack of data directly quantifying the role of vegetation in mitigating hazards.

MDG BOOST ↑1, ↑7

Sources: PreventionWeb, Khazai et al. (2007), Lewis III (2001), Chan & Baba (2009), UNISDR

HURRICANE RESISTANT HOUSING

9

Prevention of damage to life and property, particularly by reducing how vulnerable a population's housing and community buildings are to floods and typhoons.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Medium				
FEASIBILITY	Very High	Short-Term	✓	Implementation Lapse	Typically after 2-3 years
SCALABILITY	Medium				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Varies, depending on extent of retrofitting/ construction

Expense: approximately $2,000,000

Impacts Addressed: **Floods, storms, tsunami**

Hurricane-resistant housing programmes rate highly for feasibility. They are successful if they are targeted at areas prone to seasonal storms, and should specifically target areas that have been assessed as vulnerable.

Co-benefits of hurricane-resistant housing or shelters include fewer personal injuries and material losses in seasonal hurricanes. In Vietnam, the houses of 1,300 low-income households were strengthened directly as a result of the programme. Recently, new construction has accounted for 60 percent of the houses completed through the programme, reflecting the weak state of housing. Families no longer bear the cost of hurricane recovery, enabling them to channel their budget to other activities.

There is high variability in the cost-effectiveness of this programme due to the uncertainty of storm impacts. However, retrofitting can still be cost-effective if it results in a 60% reduction in vulnerability for a cost not exceeding 5% of the initial building cost.

The programme received a low rating in scalability due to the lack of well-documented programme examples and available training.

There is an adequate evidence base for this programme. Many case studies address economic impact; however, few studies look at the cost-effectiveness of the programme.

MDG BOOST ↑7

Sources: UNISDR (2007), Stewart et al. (2003), World Bank (2009), UNDP (2007)

FLOOD CONTROL

10

Predicting floods in highly flood-prone areas and effectively intervening. Such a programme includes mapping of vulnerable areas, developing adequate drainage, and taking steps to prevent floods.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically after 0.5-1 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: from $13,000 - $900,000

Impacts Addressed: **Flooding, excess rainfall**

Flood-control programmes rate highly for scalability, cost-effectiveness, and co-benefits. There are many case examples available, and various NGOs and universities offer training programmes. The programme is cost-effective. In Bihar, India, a flood-control project that included physical interventions and capacity building had a cost-benefit ratio of 3.76.

The programme can be implemented in the short to medium term but will not reach a positive cost-benefit ratio until the long term.

In contrast to programmes that rely on structural measures for flood control, those that are "people-centred" appear to be highly resilient under a wide variety of conditions and are economically efficient.

Co-benefits are consistent in areas with seasonal flooding. Not all communities will have the local capacity to carry out an implementation. Programmes should be sensitive to social and cultural issues that can play a large role within the community.

MDG BOOST ↑1, ↑7

Sources: Oxfam/Tearfund (2004), Caspari & Pokhrel (2008), NAPA Bhutan (2006)

PRE-POSITIONING OF ASSETS

11

Build up food storage capacity and stockpile essential food and non-food items; set up and maintain community network awareness; and develop strategies for preparedness.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically after 0.5 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✗	Programme Cycle	Typically 1 year

Expense: $388,000

Impacts Addressed: **Human health**

Programmes that pre-position assets rate highly on scalability, cost-effectiveness, and co-benefits. The Red Cross and other NGOs provide technical specifications and guidelines as well as training programmes. Many well-documented case examples also exist.

Compared to conventional procurement and disbursement of emergency supplies, the programme is highly cost-effective in the event of a natural disaster. Timing is of the essence when pre-positioning assets. Depending on the area in question, the programme is generally short-term.

All groups in a post-disaster environment benefit from such a programme, especially the poorest and most vulnerable. Factors such as facility location, inventory management, and network flows determine the impact and co-benefits.

The programme is logistically complex and assumes that disaster threats have been thoroughly assessed. Also, local infrastructure conditions (pre- and post-disaster) can limit the relief operation.

MDG BOOST ↑1

Sources: DCPP, Duran, Gutierrez, and Keskinocak (2010), NAPA, Tuvalu (2007), ReliefWeb (2009)

Workers construct a flood wall to protect buildings in the United States. Source: FEMA/Liz Roll.

HABITAT LOSS

Vast territories of the world and millions of its inhabitants are seriously exposed to desertification and sea-level rise.[253] Most of the measures used to counteract the effects of these trends involve major environmental management projects, which run into the millions or tens of millions of dollars and take years to implement. As more and more areas come under serious stress due to sea-level rise and desertification in the period through 2030, the costs of responding to those problems will increase. Given the fact that most programmes take time to deliver positive results, it is important to implement them quickly in areas where the impacts are currently the most extreme.

HIGH
Overall Effectiveness Rating

14 #Actions Assessed

FINDINGS

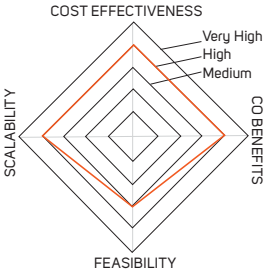
The impacts of desertification and sea-level rise are being felt around the world. In some of the larger countries, the number of people directly affected by desertification can run into the hundreds of thousands, even millions. Such populations are under extreme stress as their lands dry up and whole regions become unsuitable for productive use. Sea-level rise, meanwhile, affects the more than 1 million kilometres of the world's coastline and immediate hinterland.[254]

Only around 30-40 countries experience the main effects of desertification. The most intense impacts are taking place in Southern and West Africa. The largest populations at risk from desertification are in India, China, and the United States, which in 2010 have more than 2 million people threatened. This figure will rise to nearly 8 million by 2030.

Damage from rising seas is more widespread, since every coastline on the planet is affected. The worst effects are still quite concentrated in either relative (mainly small island states or river estuaries in Africa and Asia) or absolute terms (wealthy low-lying nations like Holland) and primarily affect fewer than 30 countries (aside from a number of very small island nations not included in our analysis). Where sea-level rise is most acute, its effects are final. Desertification and sea-level rise share many of the same effects, in particular the slow decimation of fertile soil, not only by heat and water stress, but also by salt intrusion into land and water supplies.[255] However, it is coastal land, not desert borderlands, that will completely disappear at a slow but unstoppable rate throughout the 21st century, eroding into the sea and not returning.[256]

Rapid and accelerating desertification is often caused by human activities linked to agriculture, in particular burning, over-grazing, over-cultivation, unsustainable deforestation, and over-exploitation of water supplies. Climate heat and water shocks worsen man-made land degradation in dryland regions and may further expose vulnerable communities that are dependent on ecosystems as a buffer

REVIEW FINDINGS



to climate-induced threats.[257] Growth of populations and economic activity compound these environmental pressures leading to desertification.

Tackling the loss of human habitat is still a pioneering field and is, in some cases, practically cost-prohibitive. One livestock management programme in Eritrea to protect some 1,000 people from the worst effects of desertification is estimated to cost USD 5 million for three years of protection.[258] For sea-level rise the costs can be even higher, but so can the losses. Consider the USD 10 billion per year cost that China already faces or the nearly 30% of GDP potential of Guinea-Bissau.

With expenses so high, the international community may soon have to choose which communities will be protected and which must be relocated. Migration can be considered a cost-effective adaptation tool where habitat loss hits hardest. The cultural cost to communities would be severe. Most of us today simply cannot fathom the total relocation of entire island or dry-region communities.

IF MEASURES ARE IMPLEMENTED ADEQUATELY, A NUMBER OF PROGRAMMES WILL CONTINUE TO DELIVER BENEFITS FOR DECADES TO COME

THE REVIEW

The most promising measures to counter the effects of habitat loss are, overall, less cost-effective than measures to manage other climate-related problems, such as disease and extreme weather.

The cost of habitat-loss intervention is typically measured in the millions and often involves a serious capital outlay that is not directly tied to a private commercial concern. So the building of a sea wall, the planting of trees, or the elevating of key infrastructure by several metres is a costly method of protecting populations and their assets when compared to other measures assessed in this report.[259] Some of the cheapest actions assessed here include a half million dollar effort to conserve and restoration of vegetative cover (such as dryland grasses) in areas threatened by desertification and a 1 million dollar per-implementation programme to restore mangrove forests in coastal areas.[260] Upgrading drainage systems threatened by coastal flooding, however, can cost USD 20 - 40 million.[261] Despite such expenses, several studies have documented that such actions are still cost-effective compared to the potential losses.[262]

Just as desertification is caused by factors other than climate change, the measures to combat it also protect populations from wider concerns.[263] This is less true for actions that address the effects of sea-level rise. In fact, many measures in this area actually have negative effects on the environment. Coastal barriers, for example, reduce tidal flow from the sea, trapping water inland and forcing more salt into the soils of the littoral, rendering even more land unfertile.[264]

Poor communities will rarely be able to access the type of long-term, infrastructure-intensive adaptation measures required to protect against habitat loss. This means the worst-affected communities are particularly dependent on international assistance in order to adapt and not be displaced from their homelands.

Scalability of habitat-loss programmes, however, is made easier by the fact that such programmes have typically been implemented a number of times before, so technical specifications and training programmes are usually available.

Despite isolated good examples, however, evidence indicates that most actions rate low on cost-effectiveness. Interventions are complex, and it's difficult to make any generalizations regarding the costs involved, so effectiveness often needs to be assessed on a project-by-project basis. Several implementation risks are also of concern, such as extreme weather hazards to beach extension/nourishment projects, or land-use conflicts among local communities of farmers and fishermen in cases of dryland restoration programmes or mangrove plantation efforts.[265] More quantitative information would help local policy-makers and communities prioritize their efforts to adapt to desertification and sea-level rise.

MEASURES TO COMBAT DESERTIFICATION ALSO PROTECT POPULTATION FROM WIDER CONCERNS

TIMEFRAME CONCERNS

Almost every programme assessed here takes two to five years to implement. With only a handful of exceptions, most measures that address habitat loss take several years to put in place. Given that many vulnerable countries have yet to implement such projects, millions of people are currently either suffering s erious economic losses –particularly populations that depend on agriculture for their livelihoods – or are being forced to flee the worst-affected zones.[266]

If measures are implemented adequately, however, a number of programmes will continue to deliver benefits for decades to come and will show long-term returns on the initial capital outlay. Forests of mangroves or dryland trees, for instance, will continue to deliver benefits for more than 20 or 30 years. Robust sea walls, if well maintained, could protect for a century or more against coastal risks.

Deard trees form an eerie tableau on the shores of Maubara Lake in Timor-Leste. Source: UN Photo/Martine Perret.

HABITAT LOSS **ADAPTATION ACTIONS**

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
1	COASTAL PROTECTION (SEA WALLS AND DIKES)	• Inundation (loss of dryland) • Erosion (direct and indirect change)		Medium	Medium
2	BEACH NOURISHMENT	• Inundation (loss of dryland) • Erosion (direct and indirect change)		High	High
3	MANGROVE BARRIERS AND RESTORATION	• Saltwater intrusion		High	Very High
4	"BACK-AWAY" ELEVATION	• Erosion (direct and indirect change)		High	High
5	SALTWATER-INTRUSION BARRIERS	• Saltwater intrusion		Medium	Medium
6	LAND-USE PLANNING	• Wetland loss (and change)		Medium	Medium
7	DRAINAGE SYSTEMS UPGRADE	• Rising water tables and impeded drainage		Very High	High
8	CONSERVATION AND RESTORATION	• Desertification		Medium	Medium
9	SOIL CONSERVATION	• Desertification		High	Very High
10	FORESTATION	• Desertification		High	Very High
11	ENHANCED LIVESTOCK MANAGEMENT	• Desertification		Medium	Low
12	INTEGRATED COASTAL MANAGEMENT	• Wetland loss (and change)		Medium	Medium
13	POLDER CONSTRUCTION	• Rising water tables and impeded drainage		Medium	Medium
14	RELOCATION/ NEW HOME IMPROVEMENT	• Sea-level rise, flooding, typhoons		High	Medium

 Population in low-elevation zones  Dryland populations  Farmers

COASTAL PROTECTION (SEA WALLS AND DIKES)

1

Create coastal sanctuaries to act as buffers to extreme climate-related events

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically after 2-5 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	5 years

Expense: $1 million +

Impacts Addressed: **Sea-level rise, flooding, coastal erosion**

Coastal protection programmes rate highly on co-benefits and scalability. The programme benefits human health and food security and targets all groups regardless of income. In Mozambique, a five-year coastal management programme is expected to positively impact biodiversity, agriculture, and water supply and sanitation.

Programme descriptions are available through the UNFCCC NAPA database, and many training programmes exist. The programme is also cost-effective, with a cost-benefit ratio of 1.2 for sea walls and 1.4 for dikes. Implementation is relatively consistent and occurs over a two- to five-year timeframe.

Several implementation risks are associated with the programme, including extreme climatic events during the construction of protection barriers, loss of access to beaches, and a potential for tourism decline.

Many studies are available through UNEP, UNFCCC, and the World Bank. The programme could benefit from further quantitative assessment.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Mozambique (2008), Cazenave & Llovel (2010), NAPA, Benin (2008), NAPA, Cape Verde (2007)

BEACH NOURISHMENT

2

Beach stabilization, wetland rehabilitation, and extension of beaches to absorb storm surge.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically after 3 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $2 million +

Impacts Addressed: **Sea-level rise, flooding, coastal erosion**

Beach nourishment programmes rate highly on cost-effectiveness, co-benefits and scalability. Although cost consistency is dependent on local cooperation and available resources, the cost-benefit ratio is 0.2, and implementation can occur in as little as three years.

Co-benefits include protection against erosion and sea-level rise and are consistent where the programme is successfully implemented. The programme targets all groups regardless of income. In The Gambia, programmes to improve coastal defences are also expected to improve livelihood security and preserve biodiversity and ecological assets. For example, rehabilitation of the Kotu stream will prevent flooding of homes and restore rice cultivation.

Technical specifications and guidelines are readily accessible. Training programmes exist, and there are some well-documented case examples. Peer-reviewed studies are available from UNEP, UNFCCC and the World Bank. The programme could benefit from greater quantitative assessment and the development of more training programmes.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), Nicholls et al. (2007), NAPA, Gambia (2008)

MANGROVE BARRIERS AND RESTORATION

3

Replanting mangrove forests in degraded areas to protect coastal areas from storms.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically after 2-4 years
SCALABILITY	High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 7 years

Expense: $1 million +

Impacts Addressed: **Sea-level rise, flooding, coastal erosion**

Mangrove barrier and restoration programmes rate highly on cost-effectiveness, co-benefits, and feasibility. With a 0.0 cost-benefit ratio and an implementation timeframe of three years, the programme is highly cost-effective.

The programme ranks high in co-benefits, targeting all groups regardless of income. In Cambodia, a mangrove restoration programme will protect neighbouring areas from windstorm, seawater intrusion and coastal erosion; enhance biodiversity; and reduce poverty through increased job opportunities. Additionally, recent evidence has shown that mangrove forests reduce vulnerability to tsunami damage.

Although the programme receives a high rating for feasibility, it may encounter problems with land availability and conflicts over land use. Weak social capital in local communities is also a barrier, posing a potential risk to ongoing projects.

Programme specifications and guidelines are available through the UNFCCC NAPA database. NGOs and universities do offer training programmes, but they are not all accessible to the general public.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), NAPA, Cambodia (2008), NAPA, Congo (2006), NAPA, Djibouti (2006), OXFAM/ Green Coast Nicholls et al. (2007), World Bank (2008)

"BACK-AWAY" ELEVATION

4

Restrict all new buildings to at least a four-meter elevation ("back away").

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Medium				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Varies

Expense: Unknown

Impacts Addressed: **Sea-level rise, coastal erosion (direct and indirect)**

"Back-away" elevation programmes rate highly on cost-effectiveness, co-benefits, and feasibility. With a 0.0 cost-benefit ratio, and implementation possible within one year, the programme is highly cost-effective. In Samoa, cost-benefit analysis revealed that 54 percent of the damage expected to occur in 2030 during a 250-year coastal flooding event can be averted by a set of four cost-efficient adaptation measures, including elevation programmes. Co-benefits include the improvement of livelihoods, prevention of saltwater intrusion, and enhancement of fresh water quality.

Extreme weather conditions or local policy conflicts may impact the programme's success. In Samoa, implementation of a mandatory land-use plan could cause conflict between central authorities and local chiefs. Also, geographic variance, even at a local level, can make back-away elevation impossible in some areas.

Various peer-reviewed studies and qualitative assessments are available through the World Bank, UNFCCC and UNEP. The programme could benefit from additional case examples and more training programmes to better ascertain its broad effects.

MDG BOOST ↑7

Sources: ECA Working Group (2009), Nicholls et al. (2007)

SALTWATER INTRUSION BARRIERS

5

May include construction of irrigation wells, development of integrated watershed management programmes, construction of structures to conserve soil and water, groundwater monitoring, and capacity building to protect freshwater sources.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 3 years
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million +

Impacts Addressed: **Sea-level rise, saltwater intrusion**

Saltwater intrusion barrier programmes rate highly on co-benefits by improving livelihoods and fresh water quality and protecting coastal agriculture. In Eritrea, a groundwater-recharging project is also expected to improve wildlife habitats, food security, and health and nutrition, and to reduce poverty.

Programme costs are initially high, with results in the long term. Consistency of costs depends on available funds and local capacity. The feasibility of the programme may be hindered by a lack of existing national legislation on the proper use of groundwater, delays, budget shortages, and/or extreme weather conditions. The programme's success depends on commitment at both the community and policy-making level.

Various peer-reviewed studies and detailed qualitative assessments are available through the World Bank, UNFCCC and UNEP. The programme could benefit from more accessible technical specifications and guidelines and from additional training resources.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), Nicholls et al. (2007), NAPA, Eritrea (2007)

LAND USE PLANNING

6

Land use planning is the term given to public policy that directs how land in a community is used, while balancing the needs of the people who live in the area with the environment. It involves studies and mapping, multi-stakeholder dialogue, and formulation of alternative land-use decisions.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $1 million +

Impacts Addressed: **Sea-level rise, rising water levels**

Land use planning programmes rate highly on co-benefits and scalability. The programme targets all groups, regardless of income, and serves to improve biodiversity and food security. In Cuba, national land use planning and management are integrated with disaster risk reduction, contributing significantly to the management of fragile coastal areas. High-risk coastal settlements were identified by producing hazard and vulnerability maps, and land-use regulations for retrofitting, resettlement, and urban growth were developed.

The programme has many strong, well-documented case examples. Technical specifications and guidelines are widely accessible. The programme is relevant to low-income countries and mega-cities in medium-income countries.

Costs for the programme are high, and there is no clear cost-benefit ratio. Long-term implementation is necessary before effects can be seen. Feasibility is highly dependent on the political context. The process often involves competing interests and values, so a high level of cross-sector cooperation is essential. Lack of funds and technical capacity can also hinder programme implementation.

Various peer-reviewed studies and detailed qualitative assessments are available through the UNFCCC and UNISDR. The programme could benefit from additional training resources and quantitative assessment of the programme's impact.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), UNISDR (2007), NAPA, Ethiopia (2008), Nicholls et al. (2007)

DRAINAGE SYSTEMS UPGRADE

7

Increase capacity of existing drainage systems to handle more frequent storms, increased rainfall, and rising sea-level.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1-2 years
SCALABILITY	Medium				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $20-$50 million

Impacts Addressed: **Rising water levels and impeded drainage**

Drainage system upgrade programmes rate highly on cost-effectiveness and co-benefits. The cost-benefit ratio is 0.33 for drainage system maintenance and 0.29 for drainage system upgrade projects. Implementation is possible within a year. However, depending on the magnitude of the project, a one-two year implementation timeline is also possible. The programme targets all groups and may reduce the prevalence of diarrhea, malaria, waterborne diseases and malnutrition, although more research is needed in this area.

In Bolivia, expansion of sewerage networks into low-income areas and construction of new wells is expected to have significant positive impacts on public health by improving access to clean water.

The programme's feasibility may be threatened by a lack of external funding and a lack of cooperation on local and policy-making levels. Also, extreme weather conditions may postpone or even destroy existing projects.

The programme is relevant to middle and high-income countries in addition to low-income countries. The World Bank, UNFCCC, and UNEP have published studies on such programmes, and robust quantitative assessments have been performed for some projects. However, few examples of technical specifications and guidelines exist, and training resources are scarce.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), World Bank (2005), GEF (2010)

CONSERVATION AND RESTORATION

8

Reforesting, replanting, restoration, and rehabilitation of existing woodlots in degraded areas using native, drought-resistant forest species.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically after 2-3 years
SCALABILITY	Very High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $500,000

Impacts Addressed: **Desertification**

Conservation and restoration programmes rate highly on co-benefits, scalability, and feasibility. Co-benefits include improvements in biodiversity, human health, and food security. In Burundi, the long-term results expected from the program include reconstruction of hydrological and weather-regulation systems and increased agricultural production.

The programme is very relevant to low-income countries and has many well-documented case examples. For example, the "Conservation and Rehabilitation of African Lands" programme recognizes the importance of vegetative conservation and restoration and prioritizes actions for managing forest resources and rehabilitating plants to control desertification.

The programme shows consistent results where implemented. As the project involves several sectors, feasibility is highly dependent on strong coordination between local partners. Also, poverty may drive local populations to clear restored forest areas.

Further information is needed to determine the programme's cost-effectiveness.

Several high-profile empirical studies have been done. Although there is already relatively high recognition at the policy-making level, the programme warrants increased attention in the future.

MDG BOOST ↑1, ↑7

Sources: UNCCD (2004), NAPA, Rwanda (2007), NAPA, Burundi (2007), Waithaka et al. (2010)

SOIL CONSERVATION

9

Conserve soil by building infiltration ditches around homes, planting grass cover, using terrace farming, digging trenches to divert runoff, mulching, and tree planting. Such projects reduce the vulnerability of regions affected by erosion and floods.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 4-5 years
SCALABILITY	Medium				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 8-9 years

Expense: $1 million +

Impacts Addressed: **Desertification**

Soil conservation programmes rate highly on cost-effectiveness and co-benefits.

The cost-benefit ratio of the project is -0.2. Co-benefits include improvement of infrastructure and protection against floods. In Rwanda, the programme is also expected to stem migration of populations in search of suitable land for agriculture.

The programme is highly relevant to low-income countries. Awareness programs, education, and training in resource use addressed to farmers, local offices, and ministries of agriculture have been developed. A few well-documented case examples from Sub-Saharan Africa exist.

The amount of funding and technical expertise available may affect the programme's feasibility. Also, land policy, actual land occupancy, and complex farming practices may hinder implementation. Several high-profile empirical studies are available, and there is relatively high recognition for the programme, but more attention is needed in the future.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), NAPA, Burundi (2007), NAPA, Rwanda (2007), Waithaka et al. (2010)

FORESTATION 10

Establishing forests, naturally or artificially, on areas that may or may not previously have been forested.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million

Impacts Addressed: **Desertification**

Forestation programmes have a wide range of co-benefits, are easy to scale up, and are cost-effective and feasible. The programme also positively impacts agriculture, food security, and desertification. In Uganda, where forestry contributes to economic development and general well-being, increased employment opportunities are expected to be a significant by-product of forestation.

UNCCD's globally launched Thematic Programme Networks (TPNs) provide extensive technical specifications and guidelines. Also, the "Mediterranean Forest Action Programme" (MED-FAP) intends to address the main problems related to sustainable management of plant formations and the promotion of forestry in controlling desertification in the Mediterranean region.

The cost-benefit ratio is between 0 and 1 for medium-income households. Results will only occur in the long term, as the project requires tree growth. Project costs will vary based on geography. Forest plantations in arid and semi-arid zones may have few beneficial effects unless they are closely related to the needs and priorities of the local population. So it is important to integrate forestation into farming systems not only for the purpose of growing trees but also to improve the welfare of rural families.

Successful implementation can be undermined by insufficient funding and limited knowledge as well as by natural hazards, pests, and civil conflicts.

MDG BOOST ↑1, ↑7

Sources: NAPA, Rwanda (2007), Waithaka et al. (2010), Dahal (2006) , NAPA, Burundi (2007), UNCCD & Joint Liaison Group of the Rio Conventions (2007), NAPA, Uganda (2007), UNCCD (2004)

ENHANCED LIVESTOCK MANAGEMENT

11

Enhance the ability of livestock production systems to adapt to changing climatic conditions, such as drought and strong inter-annual precipitation

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically after 3 years
SCALABILITY	Medium				
EVIDENCE BASE	Low	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $5 million+

Impacts Addressed: **Desertification**

Enhanced livestock management programmes rate highly for co-benefits. This programme is applicable to all groups, regardless of income, and enhances biodiversity and food security. In Uganda, a drought adaptation project includes promotion of a suitable, community-led livestock and animal-products marketing system. In the long-term, the project is intended to restore household food security, improve the quality of food consumed, and increase household income.

The programme requires close cooperation between farmers and local agencies. Potential barriers to this programme include inadequate funding and insufficient community participation. In Eritrea, programme challenges have included limited access to technical know-how at the local level and little ability to increase livestock production through best use of available resources.

The programme is highly relevant in low-income countries. Training programmes exist through UNDP country offices and local NGOs. The cost-effectiveness of the programme has not been determined. However, the programme could benefit from additional case studies and cost-benefit analyses.

MDG BOOST ↑1, ↑7

Sources: LDCF/NAPA (2007-2009), NAPA, Eritrea (2008), Waithaka et al. (2010), UNFCCC, LDC Expert Group, GEF (2009)

INTEGRATED COASTAL MANAGEMENT

12

Increase the resistance capacity of coastal zones through integrated management of coastal resources. Includes experimenting with a variety of construction materials, alternative means of construction, local early warning systems, and training.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 5 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Varies

Expense: $1 million +

Impacts Addressed: **Sea-level rise, wetland loss (and change)**

Integrated coastal management programmes rate highly on co-benefits and scalability.

Co-benefits include improved ecosystems, infrastructure, and economic activities. People are also less likely to be displaced from their communities. An integrated management programme in Cape Verde will also support economic development by supporting tourism infrastructure located in coastal areas.

The programme is especially relevant to small island nations. Technical specifications and guidelines are generally available through the implementation programme. Training programmes and information are available through the NAPA project "Adaptation to Climate and Coastal Change in West Africa".

The cost-effectiveness of the programme has not yet been clearly determined. The programme may be unfeasible due to a lack of external funding, which is critical to implementation. Also, extreme weather conditions may postpone or hinder the implementation process. Peer-reviewed studies and detailed qualitative assessments are available through UNFCCC.

MDG BOOST ↑1, ↑7

Sources: NAPA, Cape Verde (2007), Nicholls et al. (2007)

POLDER CONSTRUCTION

13

Construction of small or large polders to prevent the water table within the polder from rising too high.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 8 years

Expense: $1 million +

Impacts Addressed: **Rising water tables, Coastal inundation**

Polder construction programmes rate highly on cost-effectiveness, co-benefits and scalability. The project is considered cost-effective and usually has a three-year implementation timeframe. In addition to reducing flooding, polder restoration projects improve and restore biodiversity and human health and increase agricultural production.

Few technical guidelines are available for this programme. Training programmes, however, are available through IPCC and Caritas International. Roadblocks to successful programme implementation include a lack of awareness at the community and policy-making level and a lack of technical assistance and tools. The programme is also sensitive to weather changes, such as extreme sea-level rise or flooding. In Bangladesh, drainage congestion due to sea-level rise and inundation has been identified as a threat to polder performance.

Peer-reviewed studies and detailed qualitative assessments are available through IPCC. The programme could benefit from further cost-benefit analyses and increased awareness as well as momentum to implement the programme in local and national planning projects.

MDG BOOST ↑1, ↑7

Sources: Mohal, Kahn & Rahman (2007), NAPA, Bangladesh (2005)

RELOCATION/NEW HOME IMPROVEMENT AND ELEVATION

14

Elevating new homes on concrete piles, securing roofs with metal straps and nails, or relocating highest-risk homes to safer locations.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically after 1 year
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Varies

Expense: $500,000

Impacts Addressed: **Sea-level rise, flooding, typhoons**

Programmes that target relocation/improvement and elevation of homes rate highly on cost-effectiveness and co-benefits. Implementation is possible within one year, and benefits are long-term. The cost-benefit ratio for elevating new homes is 0.33, while elevating prioritized homes for retrofitting is 2.77. Co-benefits include the improvement of human health and socio-economic conditions due to a safer environment and lower risk of losing homes and/or livestock.

Successful implementation hinges on awareness at the community and policy-making level. In cases of extreme flooding, there is a risk that elevated homes may still be risk-prone.

Peer-reviewed studies are available through UNFCCC; however, the programme would benefit from additional case studies and quantitative assessment. Further studies would also serve to heighten awareness of the programme among policy makers.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), NAPA, Eritrea (2007), NAPA, Sao Tome e Principe (2008)

ECONOMIC STRESS

For economic growth to continue in countries worst affected by climate change, it is crucial that they be able adapt to the most serious economic stresses. The poorest communities will rely on external assistance. Several major concerns, such as mass global shifting of fish stocks and coral destruction, are unlikely to be preventable to any meaningful degree by the types of local actions that are currently available. There will be further limits to adaptation on the frontlines of scorched dryland regions that receive less and less rain.[267] However, a number of effective responses could have extended benefits for socio-economic development that might far outweigh the negative effects of climate change in the near future. Adaptation to climate stresses should be seen as an opportunity to sustain the fight against the worst forms of rural poverty and hunger.

HIGH
Overall Effectiveness Rating

19 #Actions Assessed

FINDINGS

The economic cost of climate change is perhaps the least understood aspect of the climate challenge and the most difficult to gauge. Significant changes in air temperature, water temperature, rainfall, river flows, and ocean acidity will have wide-reaching effects on the environment and the economy but have not been documented in a way that enables us to fully quantify those effects.[268] It is difficult to forecast outputs and prices in agricultural markets even without factoring in climate change. Many other considerations, such as population growth, general economic activity, and resource inputs, also play into the equation.

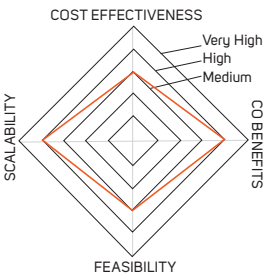
In some cases, climate change is projected to lead to net benefits in the near term.

But most often it implies net costs. Many industries are already adapting to the changes regardless of whether they are of a beneficial or a negative nature.[269]

While all sectors of the economy will feel the changes, agriculture, forestry, fishery and other primary sectors will be most affected. These sectors will reap most of the benefits but will also be hit with most of the negative effects of climate change. The effects on these sectors will also be passed on to other parts of the economy and to society as a whole.

In some cases, climate change is projected to lead to net benefits in the near term
The focus of this report is on helping areas that

REVIEW FINDINGS



THE ECONOMIC COST OF CLIMATE CHANGE IS PERHAPS THE LEAST UNDERSTOOD ASPECT OF THE CLIMATE CHALLENGE

will face the negative impacts of climate change to minimize those risks, not to advise economies profiting from climate change (those in the far north or south) on how to better reap the benefits. It is not within the scope of this report, however, to document all possible responses to all possible negative impacts. When assessing the economic stresses caused by climate change, the serious effects being felt by high-altitude or high-latitude communities due to thawing permafrost, for example, have not been taken into account. As once permanently frozen land thaws, all manner of infrastructure, from roads and bridges to homes and electricity grids, become destabilized and unsafe. The associated adaptation costs are overwhelming on a local basis. The cost of moving just one small village in Alaska, for example, has been estimated at over USD 50 million.[270]

The number of people suffering permafrost-type impacts is dwarfed by the number who, in the next 20 years, will be affected by severe productivity drops in crop production, livestock rearing, forestry and the fishing industries in warmer parts of the world. This report assesses some of the more effective responses available to these communities.

IN SOME CASES, CLIMATE CHANGE IS PROJECTED TO LEAD TO NET BENEFITS IN THE NEAR TERM

THE SUMMARY

The measures assessed in this report that relate specifically to reducing economic stress received generally high ratings for effectiveness and testify to a range of promising options already available to seriously reduce some of the main economic impacts of climate change.

Measures taken to help communities adapt to economic stress can be very costly and must be justified in the local economic context. Programmes generally range from around USD 100,000, such as for a groundwater prospecting and extraction project, to over USD 5 million for an integrated pest management scheme.[271] Governments will often have to provide significant support to help farmers and fisher folk adapt to these stresses.

The most options available relate to crop and livestock based agriculture and water stress situations. Fewer options were found for limiting impacts to the forestry and fishery sectors, based on the research behind this report. Even fewer options are available to combat major threats to land-based biodiversity, such as in rapidly warming mountainous or Polar regions.

Changes in crop management are among the simplest measures for fighting off heat, drought, water scarcity or salt intrusion in soils due to climate change. The use of newly available drought-resistant plants or simple changes in planting dates can improve yields in certain circumstances.[272] Coastal communities can also plant crops that can be irrigated with seawater alone for the price of a pump (or around USD 600 per acre). But salt-resistant crops are generally only suitable for livestock feed and yield lower returns than other cash crops.[273]

The world's poorest farmers struggle to obtain access to high-quality fertilizers and seeds, with many surviving on the least productive varieties available. These plant types will make less and less commercial sense in the world's most marginal regions as a result of climate change, forcing a switch to higher quality seeds and plant varietals. This could ultimately bring about a surge in agricultural productivity that well outweighs the negative impacts of climate change.[274] Many low-income farmers will not have resources to make the switch for the same reasons they have been unable to gain access to better supplies in the past.

Another cost-effective alternative for irrigated crops is switching to drip irrigation. This entails feeding small drops of water through tubing directly onto plants, minimizing wastage and evaporation, but again requiring installations over and above the means of most worst-affected farmers, with projects assessed here ranging from USD 100,000 to 400,000.[275]

In many cases, simply upgrading services available to farmers could help to minimize many negative impacts of climate change. In parts of Africa and Asia, for example, the most basic weather-monitoring networks are often inadequate. Additional automatic weather stations on the ground are cheap and effective and can help farmers make crucial decisions while also enabling disaster forecasting and delivering other commercial benefits.[276]

In many areas, pests and fires will increasingly threaten forests, and coastal erosion will threaten mangroves.[277] Pest management is assessed as a highly effective response here, but it also carries a high cost.[278] Other forest or mangrove plantation conservation programmes are highly effective and much less costly to implement. Sustainably managed forests and mangrove plantations also result in significant benefits to biodiversity.[279]

Proactively collecting and storing rainwater can compensate for shrinking water availability even in areas where rain will continue to decline. But collected water has to be carefully managed in order to last through extended periods of drought.[280] In the driest regions, the annual rainfall may no longer suffice for larger communities, in which case, prospecting for new sources of groundwater, sometimes far away, may be the only alternative to relocation.

Conservation-type programmes are among the best-documented measures to reduce the economic impact of climate change on fisheries. Projects include the creation of marine sanctuaries to allow aquatic life to regenerate, and monitoring and re-propagating threatened coral or shellfish. It's unclear how well such initiatives would function on a large scale.[281]

The feasibility of implementing any of the measures assessed here to counter economic stresses is a major concern. Above all, the costs are over and above the means of worst-affected communities, which makes implementation unlikely without deliberate external funding. And while a quarter-of-a-million dollar shellfish programme may prove fruitful for a three-year duration to a local island community of a few thousand people in the South Pacific, extending that programme to millions of stressed marine environments and coastal communities around the world would be a massive undertaking.[282]

A number of the actions assessed in this report will also require legislative changes, for example through establishing conservation areas, or involving local government services, such as with the improvement of weather monitoring networks. In areas where the institutional frameworks of government are already stressed, this will make implementation very difficult.[283]

Forest, mangrove, and marine conservation or enforced sustainable practices, may also run into competing commercial interests within communities, which might cause short-term risks to food security, if, for example, local fishermen are suddenly prohibited from wetland or coastal fishing.[284]

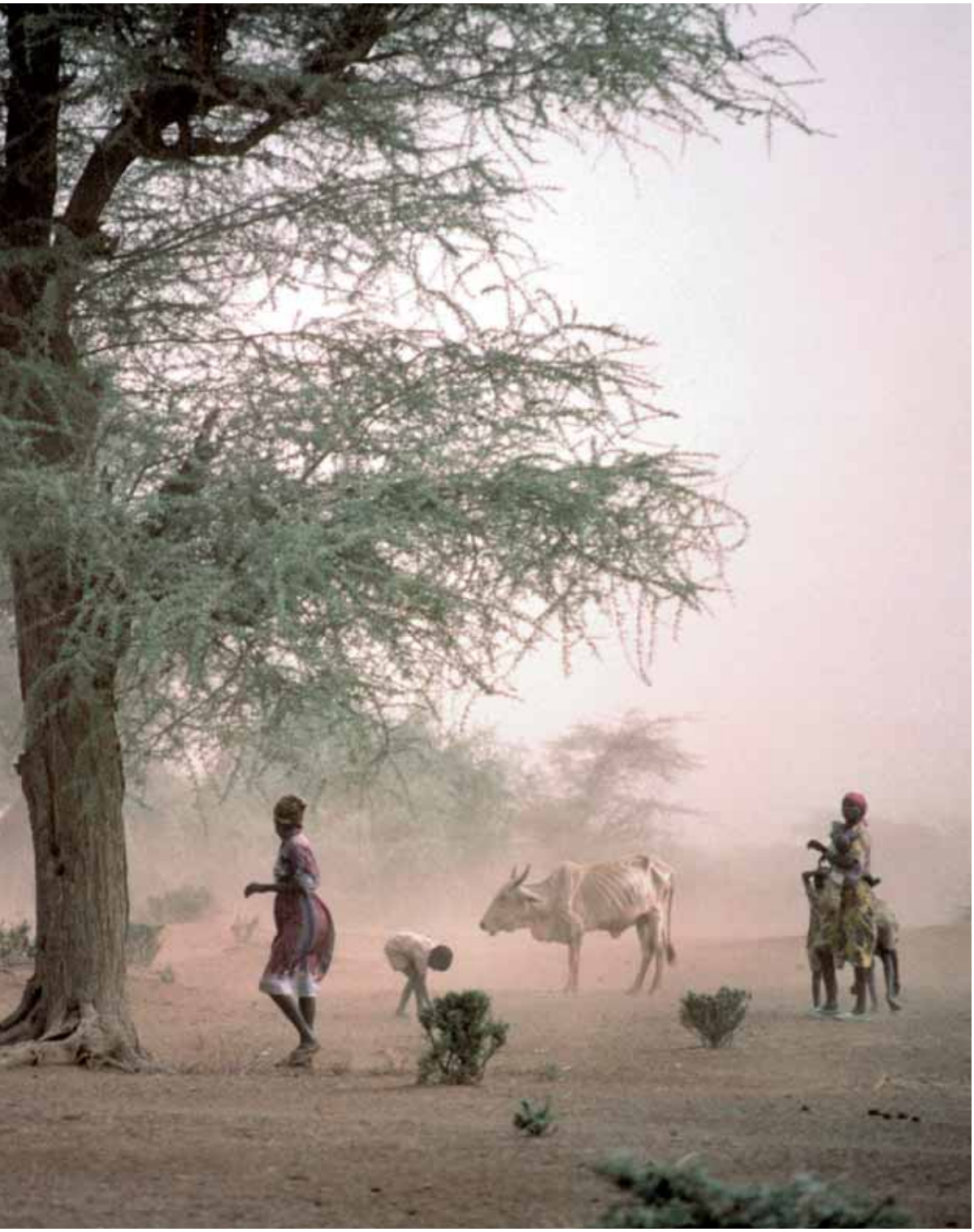
However, a number of the measures assessed here could unlock new potential across value chains if properly implemented, particularly for poor rural communities. Proper weather monitoring, for example, is a prerequisite for insurance plans based on indexes of meteorological information that are affordable even to the poor, since they pay out when rainfall drops below a certain level and do not require costly assessment procedures. Insurance can in turn facilitate access to microfinance, and microfinance can lead to the procurement of better seeds, fertilizers and other supplies. In successful cases, therefore, benefits of some of the responses assessed here could be wide-reaching.

Some of the actions assessed here are long familiar to agricultural or development communities. It has been well documented, for example, that improved roads and seeds result in higher rural output levels. These initiatives are easily replicated anywhere and will widely benefit communities in most cases. However, a number of measures, such as introducing salt-water crops, are pioneering responses to emerging concerns, and we are only beginning to see case examples that would serve as a foundation for widespread implementation.[285]

TIMEFRAME CONCERNS

A number of the measures here can be implemented almost immediately, such as installation of weather monitoring networks or even the launch of a coral or mangrove conservation programme. Such actions, however, may take much longer, often years, to achieve a positive impact.[286] Marine life may bounce back fast (as with some examples of coral reef damage) or take decades to properly regenerate even if left completely undisturbed by commercial operations. Desalination plants or micro-irrigation systems are quick fixes by comparison that will continue to reap benefits for years, although maintenance and running costs will need to be met.

Concrete water storage facilities on the other hand, may require more than a year to construct and link to local water systems. But the lifetime benefits of such systems could continue to be enjoyed by communities for much more than 10 years with only minimal maintenance



A sandstorm on the western shore of Lke Baringo, Kenya. Source: UN Photo/Ray Witlin.

ECONOMIC STRESS **ADAPTATION ACTIONS**

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
1	DRIP IRRIGATION	• Agriculture • Water scarcity		Very High	High
2	SOIL CONSERVATION	• Drought, Water Scarcity		Very High	Medium
3	CROP ENGINEERING FOR DROUGHT RESISTANCE	• Agriculture • Water stress		Very High	High
4	DRAINAGE SYSTEMS	• Agriculture • Water stress		Very High	High
5	RAINWATER HARVESTING	• Water scarcity		Very High	High
6	WATER STORAGE FACILITIES	• Water scarcity		High	High
7	CANAL LINING	• Water scarcity		Medium	Medium
8	INTEGRATED PEST MANAGEMENT (IPM)	• Agriculture • Declines in projected yields • Length of growing season		High	High
9	GROUNDWATER MANAGEMENT	• Water scarcity		Very High	High
10	MANGROVE RESTORATION AND PROTECTION	• Forestry • Erosion, wetland loss		Medium	High

Farmers | Subsistence farmers | Food-stressed populations | Rural populations | Indigenous populations | Rural population with poor energy access

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
11	COMMUNITY FORESTRY	• Forestry • Deforestation		High	Medium
12	IMPROVED CROP MANAGEMENT	• Agriculture • Declines in projected yields • Length of growing season		High	Medium
13	DESALINATION	• Salination • Water scarcity		Medium	Very High
14	SALT-TOLERANT CROPS	• Agriculture • Salination		Medium	Very High
15	ENERGY-EFFICIENT BIOMASS STOVES	• Forestry • Deforestation • Cardiovascular, Respiratory diseases		High	High
16	WEATHER STATIONS	• Agriculture • Less predictable weather patterns		High	Medium
17	AQUACULTURE DIVERSIFICATION	• Fisheries		Medium	Medium
18	SHELLFISH BREEDING PROGRAMMES	• Fisheries		Medium	Medium
19	CORAL RESTORATION	• Damage to marine ecosystems • Tourism income • Fisheries		Medium	Medium

Very low Low Medium High Very high

DRIP IRRIGATION

1

To reduce pressure on fresh water resources by dripping water slowly to the roots of plants through a network of valves, pipes, tubing and emitters.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $100,000-$500,000

Impacts Addressed: **Agriculture, water scarcity**

Drip irrigation programmes rate highly on cost-effectiveness, co-benefits, and scalability.

With a cost-benefit ratio of zero, and implementation achievable within one year, the programme is cost-effective. The primary co-benefit of the programme is food security. In Senegal, the programme is also expected to increase rural inhabitants' quality of living and reduce energy consumption.

Implementation concerns for a programme in Mauritania include maintenance and a potential lack of water to feed the system. Coordination among multiple players and sectors was also noted as vital to the programme's success.

Peer-reviewed studies are currently available through the World Bank, UNFCCC and UNEP. Recognition of the programme by policy makers is already relatively high.

MDG BOOST ↑1, ↑7

Sources: ECA WORKING GROUP (2009), NAPA, Mauritania (2008), NAPA, Senegal (2008), NAPA, Cape Verde (2008)

SOIL CONSERVATION

2

Reduce soil erosion by identifying and implementing soil conservation techniques, such as reduced tillage and mulching.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $2 million +

Impacts Addressed: **Drought, water scarcity**

Soil conservation programmes rate highly on cost-effectiveness and co-benefits. In Maharashtra, India, the programme was found to have a cost-benefit ratio of -0.2. Because soil conservation techniques involve less use of fertilizer and tillers, it can yield large cost savings. Implementation can occur within three years. Co-benefits include increased food security and improved water quality from a reduced sediment load in coastal waters.

Barriers to implementation include a possible lack of participation and interest from farmers and a lack of consistent implementation, since all farms in each programme area must participate to ensure its success.

The programme is relevant in all areas subject to loss of forest cover and inappropriate land use. Presently, technical guidelines and training programmes are limited.

MDG BOOST ↑1, ↑7

Sources: ECA WORKING GROUP (2009), NAPA, Cambodia (2008)

CROP ENGINEERING FOR DROUGHT RESISTANCE

3

Seed-engineering measures to make plants more drought-tolerant through conventional breeding.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million – $100 million +

Impacts Addressed: **Agriculture, water scarcity**

Programmes that promote crop engineering for drought resistance rate highly on cost-effectiveness, co-benefits and scalability. The cost-benefit ratio of the programme is 0.1 for irrigated agriculture and 0.7 for rain-fed agriculture. Implementation is possible within one year, although the full effects are more long-term.

The programme targets all groups, regardless of income. The main co-benefit is improved food security. In Burundi, varieties of sweet potato, sorghum, and corn are being developed to resist drought and adapt to the weak soil fertility in affected regions.

The programme is relevant to countries with a high reliance on food production from natural resources. Specifications and guidelines are available through local NGOs working in connection with the programme. Training of farmers occurs as a component of NAPA implementation.

The World Bank, UNFCCC, and UNEP have conducted peer-reviewed studies on this programme, but it could benefit from further quantitative analysis and more case examples.

MDG BOOST ↑1, ↑7

Sources: NAPA, Bangladesh (2005), NAPA, Burundi (2007), NAPA, Cape Verde (2007), UNDP/NAPA, Bangladesh (2005), ECA Working Group (2009)

DRAINAGE SYSTEMS

4

Development of irrigation and drainage systems for agricultural production.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5-10 years

Expense: $74 (Irrigated) - $80 million (Rain-fed)

Impacts Addressed: **Agriculture, water scarcity**

Drainage system upgrade programmes rate highly on cost-effectiveness, co-benefits, and scalability. Although initial costs are high, the programme has a cost-benefit ratio of -2.1 (rain-fed) to -0.2 (irrigated). Implementation is possible within a year.

Co-benefits include improved food security and water conservation. In Sierra Leone, the long-term results of such a programme include increased income among farmers, poverty alleviation, and improved food storage, processing, and marketing.

The programme's feasibility is dependent on the availability of well-trained technicians and farmers; monitoring and supervision; and the availability of essential equipment and tools. Risks and barriers include the availability of funding, a potential increase in waterborne diseases, and poor production infrastructure.

The World Bank, UNFCCC, and UNEP have carried out peer-reviewed studies on this programme.

MDG BOOST ↑1, ↑7

Sources: Sources: NAPA, Sierra Leone (2008), ECA Working Group (2009), IFPRI (2009)

RAIN WATER HARVESTING

5

Supplementing domestic/household water requirements by collecting, treating, and storing rainwater as part of a wider drinking water supply programme.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $500,000 +

Impacts Addressed: **Agriculture, water scarcity**

Rainwater harvesting programmes rate highly on cost-effectiveness, co-benefits, and scalability. The programme has a cost-benefit ratio of 0.1. A simple and affordable rainwater harvesting system combined with an integrated approach to agricultural production significantly improves the lives of local farmers. A rainwater harvesting programme in Burundi reported such benefits as an increase in farmer income, and improved food security and health due to safe drinking water. Rainwater harvesting may also help control erosion and flooding during periods of excessive rainfall.

The programme is highly relevant in low-income countries. Various rainwater harvesting technologies have been adopted successfully in many parts of the world. Programme guidelines are available through local and global NGOs, and training programmes are included as part of the implementation process.

Implementation risks include labour shortage and a lack of farmer participation. In extreme dry seasons, rainwater harvesting may fail.

Peer-reviewed studies are available through UNFCCC and UNEP. The programme would profit from greater recognition at the policy-making level and additional quantitative assessment.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Burundi (2008), NAPA, Bhutan (2006)

WATER STORAGE FACILITIES

6

Building water storage facilities for household and emergency use.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically within 2 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $200,000 +

Impacts Addressed: **Agriculture, water scarcity**

Water storage facility programmes rate highly across all assessment categories. Implementation is possible within two years. Co-benefits include improvements to agriculture and livestock, better human health, and improved water quality. Potential barriers to implementation include insufficient space to build a water storage structure, social resistance to water conservation techniques, and inadequate financing. Since the programme is dependent on rainwater, it will serve little purpose in areas of low rainfall. Projects have been successful on some islands in Tuvalu but have failed on others.

Training programmes are accessible through UNDP Global Environment Facility's Small Grants Programme International Waters Resource Guide. Peer-reviewed studies are available through UNFCCC and UNEP, but the programme would profit from greater recognition at the policy-making level and from additional quantitative assessment.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Samoa (2008) , NAPA, Tuvalu (2007), GEF (2010), GEF SGP Mauritius (2001), de Fraiture & Molden (2010)

Very low Low Medium High Very high

CANAL LINING

7

Lining canals to reduce water losses, since water losses in unlined irrigation canals can be high.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically within 2-4 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million - $10 million

Impacts Addressed: **Agriculture, water scarcity**

Canal lining programmes rate highly on co-benefits, feasibility, and scalability.

The project leads to increased food crops, which leads to increased household income. It is also beneficial to women and children, as it reduces the time and effort needed to search for water. In Tanzania, a rehabilitated irrigation canal and water reservoir increased food crops and introduced a new cash crop. Sales of the surplus provided families with income, reducing poverty and unemployment.

Potential project hurdles include a lack of local engagement and participation, and a lack of external funding. Extreme weather conditions may also affect implementation.

Guidelines, technical assistance, and training are usually incorporated as part of the overall programme. Studies have been carried out as part of UNFCCC and UNDP projects, but the programme could benefit from further cost-benefit analysis and greater attention at the policy-making level.

MDG BOOST ↑1

Sources: ECA Working Group (2009), GEF (2004), NAPA, Cambodia (2006), de Fraiture & Molden (2010)

INTEGRATED PEST MANAGEMENT (IPM)

8

Understanding how climate change affects pest outbreaks. Such a programme can result in more cost-effective pest management and is sensitive to the effects on vulnerable communities and women.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3-5 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million +

Impacts Addressed: **Pests, drought**

Integrated pest management programmes rate highly on cost-effectiveness, co-benefits, and scalability. Analyses have shown a 0.1 cost-benefit ratio for the programme in India.

Protecting crops from pests results in higher agricultural output. Long-term results for a programme in Uganda include decreased pest outbreaks, ecological shifts of vector-borne and communicable diseases and pests, improved human health, and sustained socio-economic development.

The programme is especially relevant in low-income countries, where natural resources are a main income source. The programme provides training and tests various pest-management technologies as part of the implementation process. Feasibility challenges may include inadequate funding and insufficient community mobilization and response. Natural hazards, disasters, and civil conflicts will also impede the programme's success.

The programme can result in improved food security, better human and animal health, and a reduction in diseases such as malaria. Recognition of the programme is increasing at the policy-making level, but it would benefit from additional research.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Uganda (2008)

GROUNDWATER MANAGEMENT

9

To improve the operation and use of underground water in order to protect its quality and optimize water supply.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $100,000 +

Impacts Addressed: **Agriculture, drought**

Groundwater management programmes rate highly on cost-effectiveness, co-benefits, and scalability. Analyses show a 0.7 cost-benefit ratio for the programme, with implementation possible within three years. In Mauritania, the co-benefits of a groundwater management improvement programme include more effective cultivation methods, higher agricultural productivity, and improved water quality.

Technical specifications and guidelines for the programme are available through local and global NGOs. Where implemented, local training is included as a component of NAPA projects.

Potential programme difficulties include conflicts between governing agencies over areas of jurisdiction, training of technicians, and obtaining equipment such as pumps. Water sources are also sensitive to pollution and harmful effects.

Peer-reviewed studies are available through UNFCCC programmes. The programme also complements water, sanitation, and energy sector reform.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Mauritania (2004) , NAPA, Niger (2006), de Fraiture & Molden (2010)

MANGROVE RESTORATION AND PROTECTION

10

In addition to building up land and protecting shorelines, mangroves serve as a habitat for many fish and wildlife species. The main techniques for restoring and protecting mangroves include 'planting alone', hydrologic restoration, and excavation or fill.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $250,000 - $1 million

Impacts Addressed: **Forestry, fisheries, and coastal protection**

Mangrove restoration and protection programmes rate highly on co-benefits and scalability. Rehabilitated mangrove forests provide coastal protection and can also improve economic production. In the Gulf of Thailand, fishing, environmental benefits, and flood proofing were cited as programme advantages.

The programme is highly relevant, since many low-income nations have lost high percentages of mangrove coverage. UNESCO and university programmes have developed many guidelines and specifications for techniques and training in mangrove restoration.

In the Gulf of Thailand, the restoration of 1,200 hectares of mangrove forest resulted in an estimated $100,000 economic gain to fisheries. Costs of restoration would be recovered in 2.4 - 8.4 years. The price of restoration per hectare can fluctuate significantly, depending on the method of restoration.

Programme success can vary widely depending on the environment and the techniques used. If the method of restoration is self-repairing, the project depends on the presence of waterborne seeds or seedlings from adjacent mangrove stands. Restoration also requires that normal tidal hydrology is not disrupted, further complicating implementation. Although there is already a high level of recognition for the programme at the policy-making level, the programme's success also depends on being able to raise public awareness of the value of mangroves.

MDG BOOST ↑1, ↑7

Sources: ECA Working Group (2009), NAPA, Mauritania (2004) NAPA, Cambodia (2007), Lewis III (2001)

COMMUNITY FORESTRY

11

Tree and mangrove planting to prevent deforestation and promote agroforestry.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million +

Impacts Addressed: **Deforestation**

Community forestry programmes rate highly in all areas. The cost-benefit ratio has been estimated to be between 0 and 1 for medium-income households. A community reforestation project in Tanzania aims to improve the livelihood of communities around Mount Kilimanjaro by providing alternative sources of income and food through replanting of trees and economic diversification.

Implementation risks include natural hazards and pests, insufficient funding, and civil conflicts. Forest plantations in arid and semi-arid zones may have little beneficial effects unless they are closely related to the needs and priorities of local inhabitants.

So it is important to integrate forestation into farming systems not only for the purpose of growing trees but also to improve the welfare of rural families.

Programme guidelines and training are available through UNCCD's globally launched Thematic Programme Networks (TPNs) and the "Mediterranean Forest Action Programme" (MED-FAP).

MDG BOOST ↑1, ↑7

Sources: UNCCD (2004), Dahal (2006), Waithaka et al. (2010)

IMPROVED CROP MANAGEMENT

12

Changes to crop-planting dates to maximize yield under new climatic conditions; can be combined with changes to fertilizer and irrigation.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✓	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically within 0.5 years
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✗	Programme Cycle	Typically 2-3 years

Expense: Unknown

Impacts Addressed: **Drought and/or excess rainfall**

Programmes for improving crop management rate highly in cost-effectiveness, co-benefits and feasibility. Though there is no clear determination of the programme's cost-effectiveness, in theory, planting dates can be changed without any extra cost, and such a programme can be implemented within a harvesting season.

Co-benefits include increased food security. If the new planting schedule is adopted on the regional or national scale, the programme may also assist in preventing food shortages. Poor subsistence farmers are the main beneficiaries of this programme, although it is relevant to all groups.

A drought-adaptation programme in Uganda that shifts planting seasons to maximize on shortened seasonal rains will also result in better quality of food consumed, leading to improved nutrition. And an increase in crops to sell raises the household income.

Access to weather data and research in drought-resistant crop varieties is necessary for successful implementation. Shifting weather patterns and quality of weather data are also factors to consider. Programme results may vary depending on regions and crops.

The programme is highly relevant in low-income countries, especially since it is low-cost and effective. Although overall guidelines for the programme exist, it should be implemented case-by-case based on geographical location and crop type.

MDG BOOST ↑1, ↑7

Sources: IPCC (2007), Easterling et al. (2007)

Very low | Low | Medium | High | Very high

DESALINATION

13

Seawater desalination is a well-established process, mainly for drinking-water supply, in water scarce regions.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $0.50 - $1.50/$m^3$ water

Impacts Addressed: **Water scarcity**

Desalinisation programmes rate highly in co-benefits and scalability. The programme benefits populations in water scarce areas as well as the agricultural sector. If conducted well, the programme can also result in environmental benefits to coastal sites. In Mauritius, a project developed locally-constructed solar water desali¬nation units and installed them in the remote community. Livelihood benefits include improved health and a reduced burden on women, who previously had to walk 3-5 hours per day to find drinking water.

There are many well-documented case examples, and the programme is highly relevant for all arid and drought prone/water scarce zones. Renewable energy is increasingly being used as an energy source in community-based projects.

If scaled up, this technology could offer an option for non-fossil fuel dependent water access.

The cost-benefit ratio of the programme depends on the technique used. The costs are still too high for full use of such a programme in irrigated agriculture compared to other methods such as wastewater treatment. But used for drinking water it has proved its cost-effectiveness.

Project success is highly variable. The programme normally requires long-distance transport of desalinated water to its site of use. Fluctuating energy prices are also a risk factor, as energy costs for running a desalination plant account for up to half of the programme cost.

MDG BOOST ↑1, ↑3, ↑4, ↑5, ↑6, ↑7

Sources: Ghaffer (2006), UN (2009), GEF/UNDP (1997), Beltrán & Koo-Oshima (2004)

SALT-TOLERANT CROPS

14

Growing salt-tolerant crops on land irrigated with water pumped from the ocean.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $606 per acre, on average

Impacts Addressed: **Food insecurity, water scarcity**

Salt-tolerant crops programmes rate highly in co-benefits and scalability. The programme benefits populations in arid, drought-prone, coastal nations.

Salt-tolerant crops are currently used to feed livestock. It also has potential for use in producing bio-friendly fuels. Two requirements must be met if salt-tolerant crops are to be cost-effective. First, they must produce yields high enough to justify the expense of pumping irrigation water from the sea. Second, researchers must develop agronomic techniques for growing seawater-irrigated crops in a sustainable manner.

Halophytes (plants that naturally grow in saline environments) have been singled out as the most suitable salt-tolerant crop. Research has been conducted in salt-tolerant crops for agricultural purposes but is not yet able to match the same production scale as crops intended for livestock.

MDG BOOST ↑1, ↑7

Sources: UN (2009), Hendricks & Bushnell (2009), Glenn, Brown & O'Leary (1998), Beltrán & Koo-Oshima (2004), GEF/UNDP (1997)

ENERGY EFFICIENT BIOMASS STOVES

15

Substituting traditional stoves (such as three-stone cooking fires) with more efficient chimney-fitted stoves to save energy and time.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Medium				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 2 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $200,000

Impacts Addressed: **Deforestation, respiratory illness**

Energy-efficient biomass stove programmes rate highly on cost-effectiveness, feasibility and scalability. Although no cost-benefit ratio has been determined, the programme can be fully implemented within two years.

Successful implementation depends on community awareness and willingness to adopt new cooking and heating methods. The programme is highly relevant in low-income countries, where significant populations have limited access to energy. Guidelines and training programmes are available through NAPA projects and the World Bank. The World Bank's "Fuel Source Module" also contains training resources for the programme.

The programme is projected to have a large impact on human health, biodiversity, and quality of life. Lower-income households benefit the most, since they rely more on traditional fuels than higher-income households do.

MDG BOOST ↑1, ↑4, ↑5, ↑7

Sources: NAPA, Burundi (2008), Barnes et al. (2004)

WEATHER STATIONS

16

The application of meteorology to agriculture is essential, since every facet of agricultural activity depends on the weather.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Very High	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $500,000 +

Impacts Addressed: **Food insecurity, agriculture**

Weather station programmes rate well on all assessment levels. They are cost-effective in agriculture when applied correctly and use automatic solutions.

If automatic weather stations are used, costs are consistent. The programme can be implemented within a short timeframe, but its full effects are more long-term, since an automated system requires weather data collected over time. In Bhutan, where even slight changes in monsoon patterns can result in significant changes in agricultural productivity, co-benefits include higher agricultural productivity, better food security, improved living standards, and sustainable use of natural resources.

Risks are low if the technical capability is on hand to set up the stations. Dissemination and distribution of weather data is key. If automated, standard, weather stations are used, then sensitivity to external factors is very low. However, there are key gaps in the understanding of and ability to predict the global climate system. The deteriorating state of the climate observing system in Africa, for example, presents an impediment to understanding climate effectively.

Technical guidelines and training programmes are available through the World Meteorological Organization.

MDG BOOST ↑1, ↑7

Sources: NAPA, Bhutan (2008), Stefanski et al. (2007), Plummer et al. (2003), WMO

AQUACULTURE DIVERSIFICATION

17

Establishment of marine protected areas, restoration efforts targeting the health of corals and fish, and stock enhancement to maintain a vigorous coral reef.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $500,000 - $1 million

Impacts Addressed: **Loss of marine fish stocks**

Acquaculture diversification programmes have substantial co-benefits: They improve food security, future biodiversity, and fish stocks. In Vanuatu, a community-based marine management programme aims to use national fisheries to support economic growth, create jobs, and enable sustainable development.

The programme's cost-effectiveness is unclear. Implementation may be hindered by a lack of funding and conflicting policy interests (such as fear of decreasing tourism due to restricted area access). The programme requires an awareness and understanding of local communities.

The programme is highly relevant to low-income countries due to their large dependence on natural resources. Unfortunately, few guidelines and training programmes are available. The effects of global warming on fisheries are currently not well understood but are beginning to receive attention.

MDG BOOST ↑1, ↑7

Sources: NAPA, Vanatu (2007), NAPA, The Gambia (2007), FAO (2010)

SHELLFISH BREEDING

18

Shifting vulnerable populations of shellfish to suitable sites and using marine or onshore breeding programmes will result in the natural breeding of shellfish and regeneration of the shellfish population.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $250,000 +

Impacts Addressed: **Loss of marine fish stocks, sea temperature rise**

Shellfish breeding programmes have significant co-benefits and are easy to scale-up. In Tuvalu, coral reef resources are the most easily accessible and main protein source of food for low-income and subsistence families on all islands of Tuvalu. The programme will enhance coral reef fishery biodiversity and improve socio-economic conditions in the related communities.

Guidelines from various local NGOs exist. Training programmes are primarily locally based in connection with a larger project.

The programme is estimated to be relatively high-cost, but no comprehensive evaluation has been made yet. Cost-effectiveness will most likely determine what type of breeding practice is adopted.

Community cooperation and funding availability are vital components of the programme. The programme requires an awareness and understanding of the local community.

MDG BOOST ↑1, ↑7

Sources: NAPA, Tuvalu (2007), FAO (2010)

CORAL RESTORATION

19

Monitor, restore, and enhance coral reefs to prevent coral bleaching; establish marine protected areas.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $500,000 +

Impacts Addressed: **Loss of marine ecosystems, food insecurity**

Coral reef restoration programmes have significant co-benefits and rate highly for feasibility and scalability. The programme increases the breeding of certain fish species, positively impacting biodiversity and food security. In Kiribati, coral reefs are critical to subsistence and artisanal fisheries that are the main life-supporting activities of local communities.

Implementation risks include a lack of funding and awareness and a lack of interest in implementing programmes at the local level. Increased tourism, which puts additional pressure on coral reef ecosystems, also poses a major risk to established programmes.

Programme guidelines are locally and globally available. Local NGOs are involved in training for project implementation. The programme could benefit from additional peer-reviewed study and assessment.

MDG BOOST ↑1, ↑7

Sources: NAPA, Kiribati (2007) , UNFCCC (2009), FAO (2010)

Redeveloping community in the Maldives. Source: IFRC.