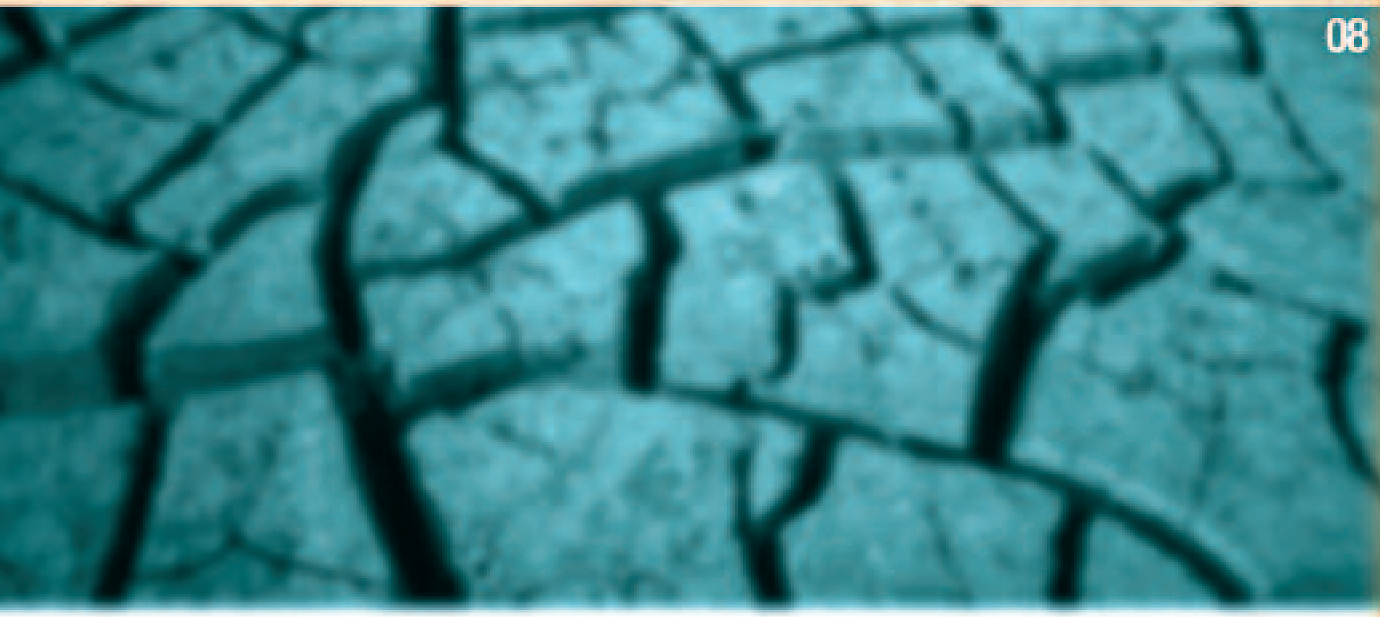
ISSN 1817-2679

NEW DIRECTIONS IN FISHERIES
A SERIES OF POLICY BRIEFS ON DEVELOPMENT ISSUES

08



BUILDING ADAPTIVE CAPACITY TO CLIMATE CHANGE

POLICIES TO SUSTAIN LIVELIHOODS AND FISHERIES

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

BUILDING ADAPTIVE CAPACITY TO CLIMATE CHANGE

The aim of this policy brief is to:

Describe how climate variability and change may influence the fisheries sector and its future contribution to poverty reduction

Report on a recent global assessment identifying regions where future climate change could have the most significant impact on the contributions of the fisheries sector to national economies

Review adaptive livelihood and institutional responses to climate variability in fisheries

Propose policy actions and initiatives to help governments and fishing communities maintain and build adaptive capacity to climate change

POVERTY REDUCTION, FISHERIES AND CLIMATE CHANGE

Fisheries ecosystems and fishing-based livelihoods are subject to a range of climate-related variability, from extreme weather events, floods and droughts, through changes in aquatic ecosystem structure and productivity, to changing patterns and abundance of fish stocks. Resource users and managers face continued challenges in responding to this variability. Human-induced climate change, which is likely to increase the frequency and magnitude of variability as well as potentially causing major shifts in ocean system productivity and surface freshwater availability, is going to make adaptation more difficult and costlier. There is increasing concern that, although climate outcomes cannot be precisely predicted, the shift in probability towards greater climate challenge is becoming clearer. Unless changes can be anticipated and brought rationally into local, national and international coping response, many of the world's development aims will be gravely compromised.

Because the fisheries sector is particularly sensitive to climate change, potential impacts on poverty reduction are a major concern. Fisheries and poverty reduction are tightly linked in many developing countries. The sector and its related activities are important for economic output and growth and employ over 155 million people worldwide – 98 percent from developing countries[1]. African export earnings are calculated to be over US$2.5 billion, and fisheries sectors in countries such as Ghana, Namibia, Senegal and Uganda contribute over six percent to their national GDP (gross domestic product). Fish is also an important and inexpensive source of protein, providing at least 50 percent of the essential animal protein and mineral intake for 400 million people from the poorest African and south Asian countries[2].

This brief outlines our present state of knowledge on climate change and its links to fisheries. It presents a global analysis of the vulnerability of economies to possible climate-related changes in fisheries and proposes policy responses to mitigate potential impacts, developed from existing coping and adaptation strategies.

EXAMPLES OF FISH STOCK FLUCTUATIONS WITH CLIMATE VARIATION

Fluctuations in wind patterns in 30 year cycles (the ACI index[3]) appear to be related to abundance of fish species. In years characterized by a north-south or south-north wind direction across the Atlantic Ocean there is a cooling of global temperatures and a corresponding increase in abundance of a group of fish species consisting of Atlantic cod, Atlantic and Pacific herring, South African sardine, and Peruvian anchovy (Group A). Conversely, years where the wind blows in a west-east or east-west direction are associated with increases in global temperature and peaks in abundance of Japanese, Californian and Peruvian sardine, Pacific salmon, Alaskan pollock, Chilean jack mackerel and European sardine (Group B).

Patterns for the Pacific herring (Group A) and Pacific salmon (Group B) are illustrated below. Pacific herring and other species in this group peaked in abundance in the 1960s associated with global warming trends. Species within Group B such as the Pacific salmon peaked in abundance in 1930s and 1990s with minimum catches in the 1960s. Patterns for species such as the Peruvian anchovy are influenced in addition by El Niño patterns, for example there was a strong El Niño in 1998 (see sharp decline in catches on Figure 3 below)[4].

Figure 1 Pacific herring catches compared to the ACI index

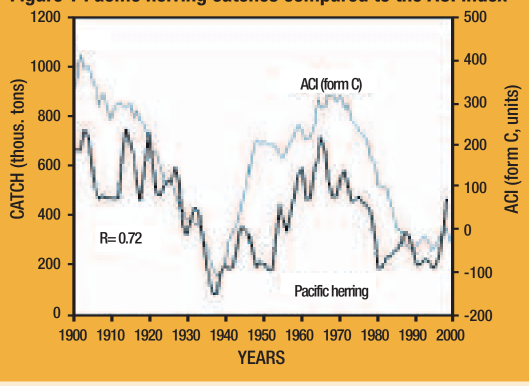


Figure 2: Pacific salmon catches compared to the ACI index

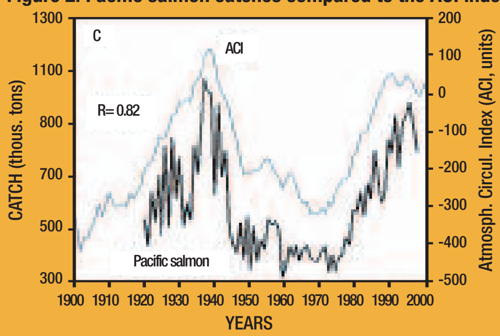
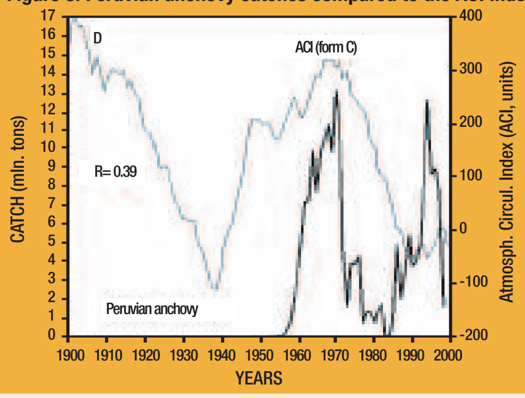


Figure 3: Peruvian anchovy catches compared to the ACI index



Source: Klyashtorin, L.B. (2001). Climate change and long-term fluctuations of commercial catches: the possibility of forecasting. FAO Fisheries Technical Paper. No. 410. Rome, FAO. 86p.

[1] ICLARM. (1999) Annual Report
[2] World Bank. (2004) Saving Fish and Fishers Toward Sustainable and Equitable Governance of the Global Fishing Sector May 2004, Agriculture and Rural Development Department
[3] Atmospheric Circulation Index (ACI) which describes wind and circulation patterns across the Atlantic Ocean. It is also related to other climate indexes such as the Length of Day (LOD) index.
[4] The El Niño Southern Oscillation is a change in the Pacific Ocean atmospheric pressure system, which affects weather and ocean behaviour. In normal years the pressure system results in prevailing offshore winds that blows warm water off the east coast of Latin America allowing cool nutrient water to flow upwards ('upwelling'). This supports a productive pelagic fishery (e.g. anchovies & sardines) off the coasts of Chile and Peru. In El Niño years, changes in pressure weaken the trade winds and upwelling, decreasing productivity of the fishery.

CLIMATE CHANGE PREDICTIONS

There is now a widely-held consensus among scientists and policy-makers that human activities are increasing levels of carbon dioxide and other ‘greenhouse’ gasses in the atmosphere, leading to a rise in its temperature. This links in turn to changes in surface temperature, varying with latitude and topography, and to thermal expansion and melting of ice caps and sea level rise. Temperature differences between land and sea, and across latitudes, drive the world’s weather and climate systems. This uneven warming is predicted to have important disruptive effects on weather and climate.

PROJECTED CHANGES IN SELECTED CLIMATE AND WEATHER PHENOMENA, WITH ESTIMATED CONFIDENCE IN PROJECTIONS

CHANGES IN PHENOMENON	CONFIDENCE IN PROJECTED CHANGES
Higher maximum temperatures and more hot days over nearly all land areas	Very likely (90-99% chance)
Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely
More intense precipitation events	Very likely, over many areas
Increased summer continental drying and associated risk of drought	Likely (66-90% chance), over most mid-latitude continental interiors
Increase in tropical cyclone peak wind intensities	Likely, over some areas
Intensified droughts and floods associated with El Niño events	Likely
Increased variability in Asian summer monsoon precipitation	Likely

RANGE OF PREDICTED GLOBAL MEAN TEMPERATURE AND SEA LEVEL RISES FOR 2015 AND 2050

Year	GLOBAL TEMPERATURE CHANGE	GLOBAL SEA LEVEL RISE
2015	0.20 - 0.70° C	0.04 - 0.06 m
2050	0.75 - 2.50° C	0.08 - 0.25 m

Source: IPCC. (2001). Climate Change 2001: Synthesis Report. Summary for Policy Makers, WTO/UNEP/IPCC, Geneva. 34 p.

The world’s oceans are affected by changes in precipitation, wind and currents, themselves the result of geographical differences in temperature and humidity of the atmosphere. Thus, important oceanic weather systems such as the El Niño Southern Oscillation (ENSO) and the Indian Ocean monsoon will be affected by global warming. Other direct effects of warming on aquatic systems include changes in precipitation, evaporation, river flows, groundwater, lake and sea levels.

SYNTHESIS OF PREDICTIONS ON THE DIFFERENT DIMENSIONS OF CLIMATE CHANGE

	TODAY	10 YEARS FROM NOW	50+ YEARS FROM NOW
CLIMATE VARIATION	Climatic variation: inter & intra annual, decadal variation, El Niño	Climatic variation more severe	Climate variation highly severe
	Extreme events: storms, flooding, droughts	More severe and frequent extreme events	Highly severe & highly frequent events
TRENDS	Slight increases in water temperatures		Large increases in water temperatures
SHIFTS	Threat of loss of coastal habitats e.g. mangroves, estuaries, coral reefs	Gradual loss of coastal habitats	Rapid loss of coastal habitats
	Threats of dramatic shifts e.g. glacial melts, flood river basins & deltas, current shifts		Dramatic shifts highly likely

CLIMATE CHANGE AND FISHERIES: PATHWAYS OF IMPACT

Climate change can affect the productivity or distribution of fishery resources of both marine and inland waters in a variety of ways:

- changes in water temperature and precipitation affect the dynamics of ocean currents, the flow of rivers and the area covered by wetlands. This will have effects on ecosystem structure and function and on the distribution and production of fish stocks;
- increased incidence of extreme events such as floods, droughts and storms will affect the safety and efficiency of fishing operations and increase damage and disruption to coastal and riparian homes, services and infrastructure;
- sea level rise, melting of glaciers at the headwaters of major rivers and other large-scale environmental changes will have unpredictable effects on coastal and wetland environments and livelihoods; and
- complex links between climate change, fisheries and other sectors will have indirect effects including fisheries being affected by changing water demands from agriculture, changing prices of and access to aquaculture feedstuffs and diversion of government and international financial resources away from fisheries management and into emergency relief after extreme weather events.

EXAMPLES OF CLIMATE IMPACT PATHWAYS ON FISHERIES

TYPE OF CHANGES	CLIMATIC VARIABLE	IMPACTS	POTENTIAL OUTCOMES FOR FISHERIES
Physical Environment	changes in pH through increased CO_2 and acidification	- Effects on calciferous animals e.g. molluscs, crustaceans, corals, echinoderms & some phytoplankton	potential declines in *production* for calciferous marine resources
	warming upper layers of the ocean	- warm water species replacing cold water species	shifts in *distribution* of plankton, invertebrates, fishes birds, towards the north or south poles, reduced species diversity in tropical waters
		- plankton species moving to higher latitudes	
		- timing of phytoplankton blooms changing - changing zooplankton composition	potential mismatch between prey (plankton) and predator (fish populations) and declines in *production and biodiversity*
	sea level rise	- loss of coastal fish breeding and nursery habitats e.g. mangroves, coral reefs	reduced *production* of coastal and related fisheries
Fish stocks	higher water temperatures	- changes in sex ratios - altered time of spawning - altered time of migrations - altered time of peak abundance	possible impacts on timing and levels of *productivity* across marine and fresh-water systems
	changes in ocean currents	- increased invasive species, diseases and algal blooms	reduced *production* of target species in marine and fresh water systems
		- affects fish recruitment success	abundance of juvenile fish affected and therefore *production* in marine and fresh water
Ecosystems	reduced water flows & increased droughts	- changes in lake water levels - changes in dry water flows in rivers	reduced lake *productivity* reduced river *productivity*
	increased frequency of ENSO events	- changes in timing and latitude of upwelling	changes in pelagic fisheries *distribution*
		- coral bleaching and die-off	reduced coral-reef fisheries *productivity*
Coastal infrastructure and fishing operations	sea level rise	- coastal profile changes, loss of harbours, homes, - increased exposure of coastal areas to storm damage	costs of adaptation make *fishing less profitable*, risk of storm damage *increases costs* of insurance and/or rebuilding, coastal households' *vulnerability increased.*
	Increased frequency of storms	- more days at sea lost to bad weather, risks of accidents increased	*increased risks* of both fishing and coastal fish-farming, making these less viable livelihood options for the poor; *reduced profitability* of larger-scale enterprises, insurance premiums rise.
		- aquaculture installations (coastal ponds, sea cages) more likely to be damaged or destroyed	
Inland fishing operations and livelihoods	changing levels of precipitation	- Where rainfall decreases, reduced opportunities for farming, fishing and aquaculture as part of rural livelihood systems	*reduced diversity of rural livelihoods*; greater risks in agriculture; greater reliance on non-farm income
	more droughts or floods	- Damage to productive assets (fish ponds, weirs, rice fields etc) and homes	*increased vulnerability* of riparian and floodplain households and communities
	less predictable rain/dry seasons	- Decreased ability to plan livelihood activities – e.g. farming and fishing seasonality	

Source: Modified from Allison, E. H. *et al.* (2005). Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor. Fisheries Management Science Programme, DFID/MRAG. www.fmsp.org.uk

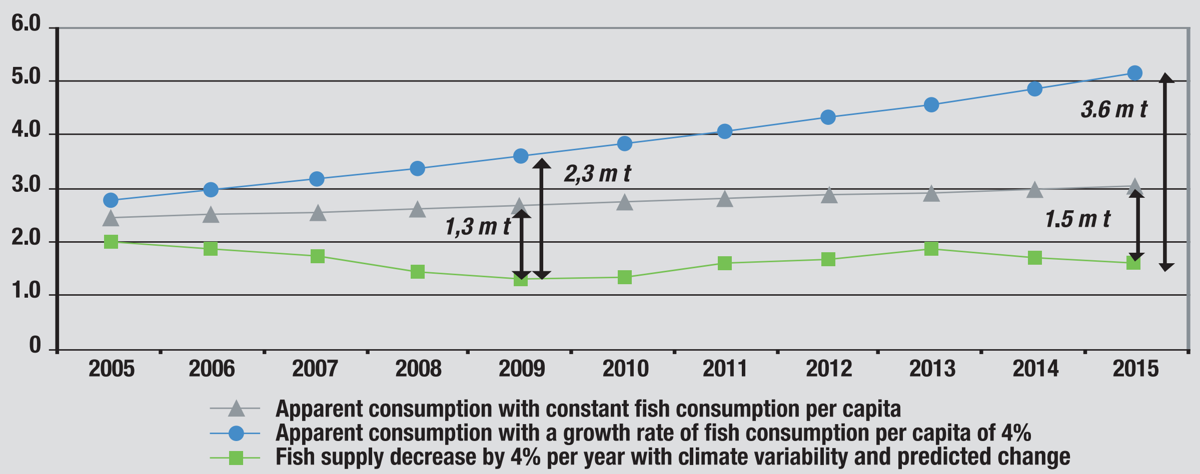
In the short term, climate change is anticipated to impact freshwater fisheries through incremental changes in water temperature, nutrient levels and lower dry season water levels. Dry-season flow rates are predicted to decline in south Asia and in most African river basins, resulting in reduced fish yields. In the longer-term, larger changes in river flows are anticipated as glaciers melt, reducing their capacity to sustain regular and controlled water flows.

For river fisheries, downstream impacts from adaptations in other livelihood sectors are a concern. In particular, conflicts exist between agricultural needs and fish productivity, and the effects of reduced flows and floodplains on seasonal spawning. Summer flows in the Ganges are predicted to reduce by two-thirds with climate change, causing water shortages for 500 million people and 37 percent of India's irrigated land.

Coastal habitats and resources are likely to be impacted through sea level rise, warming sea temperatures, extremes of nutrient enrichment (eutrophication) and invasive species. Coastal fishing communities face a double exposure of reduced fisheries resources and increased risks of coastal flooding and storm surges. Fifty million people could be at risk by 2080 because of climate change and increasing coastal population densities[5]. Projections suggest that these combined pressures could result in reef loss and a decline in fish availability for per capita consumption of approximately 15 percent by 2015[6].

Impacts of climate change are an additional burden to other poverty drivers such as declining fish stocks, HIV/AIDS, lack of savings, insurance and alternative livelihoods. There may also be increased health risks for the poor. For example, cases of cholera outbreaks in Bangladesh coastal communities were found to increase following El Niño-related flooding. Effects on agriculture and water resources will also potentially reduce water and food security. In combination, projected climate, population and market changes could have major negative effects on local fish supply in regions such as West Africa, where fish is an essential component of peoples' diet.

PROJECTED FISH AVAILABILITY (CATCHES) AND CONSUMER DEMAND WITH CLIMATE VARIABILITY (2005-2015) IN WEST AFRICA



The combination of increasing exports and weakening upwelling reducing fish production, based on a decadal cycle, will give an undersupply of 1.3 million tonnes if apparent consumption is maintained at its 2003 level and of 3.6 million tonnes if apparent consumption continues its current 4 percent actual annual increase. Upwelling off the West African coast is predicted to weaken under the influence of global warming. This will decrease fish supplies, further increasing the gap between supply and demand.

The area defined in this paper relates to the 15 countries of the Economic Community of West African States (Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Nigeria, Senegal, Sierra Leone and Togo) plus Mauritania.

Source: Failler, P. and Samb, B. (2006). Potential impacts of fish trade and climate change on fish supply in West Africa. SFLP Working Paper www.sflp.org

[5] Adger, W.N. *et al.* (2005) Social-ecological resilience to coastal disasters. Science 309: 1036-39.
[6] Allison, E. H. *et al.* (2005) Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor. DFID Fisheries Management Science Programme Project R4778J, UK. www.fmsp.org.uk

CLIMATE CHANGE IS ALREADY AFFECTING FISHERIES

A number of ecosystems in developing countries, such as lakes, rivers, wetlands and coastal zones, may already be experiencing effects of climate changes that could reduce livelihood opportunities for dependent communities.

African inland fisheries

Inland fisheries provide important livelihood opportunities in locations such as the major Rift Valley, lakes Victoria, Tanganyika and Malawi and the main water bodies of Central and West Africa, such as Lake Chad, Lake Volta and the Niger Inland Delta and the Niger and Congo Rivers.

CLIMATE CHANGE IMPACTS ON AFRICAN INLAND FISHERIES

Lake fisheries already experience high levels of climatic variability, which cause fluctuations in primary production and fish yield. Underlying these fluctuations in some parts of Africa is a trend of declining rainfall and surface water availability, and other factors that affect productivity such as changing wind regimes:

- **Lake Chilwa, in Malawi, is a 'closed-basin' lake which periodically dries out when rainfall is low but supplies up to a quarter of Malawi's fish in good years. With rainfall levels declining over southern Africa in recent years, dry periods have become more frequent and fish yields are declining accordingly.**

- **Lake Tanganyika has important fisheries for small pelagic species. Declining wind speeds and rising water temperatures have reduced mixing of nutrient-rich deep waters with the surface waters that support pelagic fish production. Along with overfishing, this may be responsible for its declining fish yields.**

- **Lake Chad fluctuates extensively, but around a declining trend. In 2005 it covered only 10% of the area it occupied in 1963, with further decreases predicted for the coming century. Fish catches have not declined to the same extent, due to increasing levels of exploitation, but the overall productive potential of the lake is declining.**

Sources: Njaya, F. and Howard, C. (2006). African Fishery at Risk from Climate Change. Tiempo 59, IIED, London.
O'Reilly, C.M. *et al.* (2003). Climate change decreases aquatic productivity of Lake Tanganyika, Africa. Nature 424: 766-768.
de Wit, M. and Stankiewicz, J. (2006). Changes in surface water supply across Africa with predicted climate change. Science 311: 1917-1921.

Coastal fisheries

Coastal fisheries include wetlands, estuarine, inshore, coral reef and open sea resources and support poor coastal communities around the world. Two-thirds of the world's coral reefs occur in the territorial waters of developing nations, together with many other coastal fisheries resources, all of which are potentially vulnerable to impacts of climate variability. Of these, coral reefs are among the most sensitive and emblematic, and coral bleaching, associated with warm sea temperatures one of the most dramatic and extensive impacts.

CLIMATE CHANGE, CORAL BLEACHING AND REEF FISHERIES

In 1998 the biggest ENSO-driven bleaching event killed an estimated 16% of the world's corals, including reefs in the Indian Ocean and Pacific. Fishing, hurricanes, bleaching and disease have resulted in a loss of 80% of Caribbean hard coral cover. As climate change is expected to increase the frequency and severity of ENSO events and hurricanes and incidence of coral bleaching, reef-associated fisheries, often important to the coastal poor, are likely to be negatively impacted.

Sources:
Goreau, T. *et al.* (2000). Conservation of coral reefs after the 1998 global bleaching event. Conservation Biology 14: 5-15.
Gardner, A. *et al.* (2003). Long-term region-wide declines in Caribbean corals. Science 301: 958-960.

GLOBAL ANALYSIS OF FISHERY SECTOR VULNERABILITY TO CLIMATE CHANGE

A recent study on the vulnerability of national economies and food systems to climate impacts on fisheries has revealed that African countries are the most vulnerable to the likely impacts of climate change on fisheries. This is in spite of over 80 percent of the world's fishers being in south and Southeast Asia and fish catches being greater in Latin America and Asia. What makes African fisheries so vulnerable? The analysis suggests that semi-arid countries with significant coastal or inland fisheries have high exposure to future increases in temperature (and linked changes in precipitation, hydrology and coastal current systems), high catches, exports and high nutritional dependence on fish for protein, and low capacity to adapt to change due to their comparatively small or weak economies and low human development indices. These countries include Angola, Congo, Mauritania, Mali, Niger, Senegal and Sierra Leone.

Fisheries provide employment for up to ten million people in Africa and provide a vital source of protein to 200 million people. Protein may be particularly limited in these countries resulting in high dependency on wild caught fish and bush meat. Other vulnerable nations include Rift Valley countries such as Malawi, Mozambique and Uganda and Asian river-dependent fishery nations including Bangladesh, Cambodia and Pakistan. Countries such as Colombia, Peru and the Russian Federation are sensitive to climate changes due to their high catches and reliance on exports or high employment from fisheries, but their larger economies and higher human development indices mean they are likely to have a greater adaptive capacity to deal with potential impacts.

GLOBAL VULNERABILITY OF FISHERIES SYSTEMS TO CLIMATE CHANGE

Vulnerability to climate change is defined by the Intergovernmental Panel on Climate Change as a combination of the potential impact (sensitivity plus exposure) and adaptive capacity.

Exposure
The nature and degree to which fisheries production systems are exposed to climate change

Sensitivity
Degree to which national economies are dependent on fisheries and therefore sensitive to any change in the sector

Potential impact
All impacts that may occur without taking into account planned adaptation

+

Adaptive capacity
Ability or capacity of a system to modify or change to cope with changes in actual or expected climate stress

= VULNERABILITY

National exposure to climate change was measured as the average predicted surface air temperature in 2050. Sensitivity represented the national relative importance of fisheries and was a composite of: number of fishers, poverty (reciprocal of per capita GDP), fish export value as a proportion of total export value, size of fisheries employment sector, total catch and contribution of fish to daily protein intake. Adaptive capacity (resilience) was a composite of human development indices and economic performance, including; life expectancy, literacy rates, school attendance, size of economy, political stability and good governance, law, accountability and corruptibility.

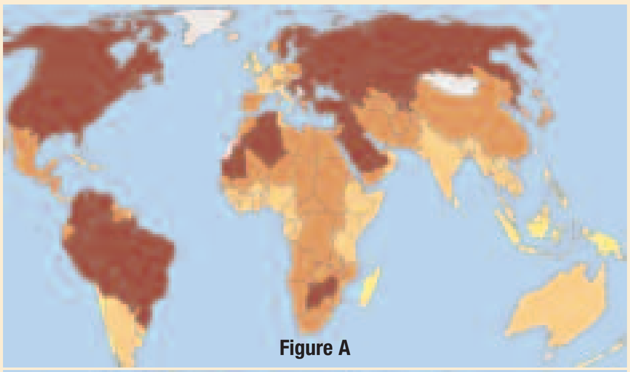


Figure A

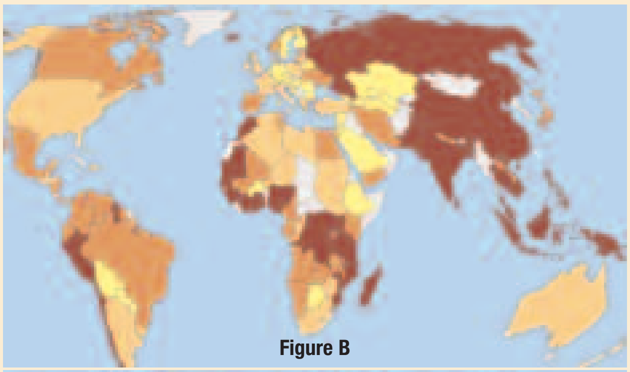


Figure B

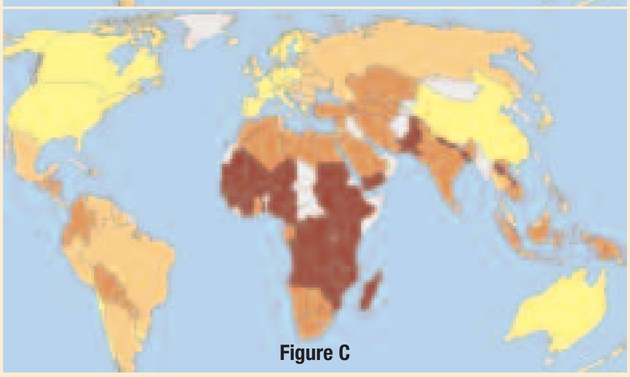


Figure C

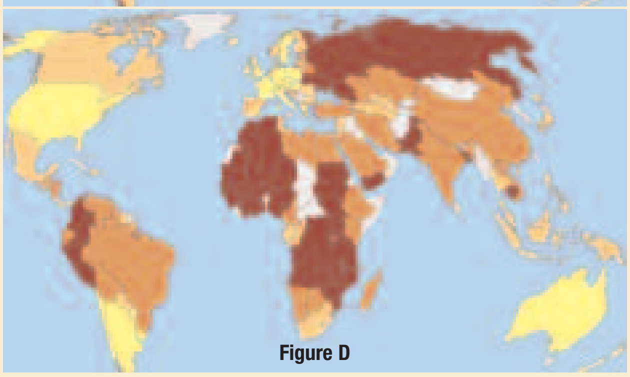


Figure D

In the figures above, the darker colours represent higher exposure to climate change (Figure A), higher sensitivity (Figure B), lower adaptive capacity (Figure C) and higher vulnerability (Figure D). West African and Central African fisheries form the bulk of the countries whose economies are most vulnerable to climate impacts on fisheries. Countries shaded in grey are those for which data are unavailable.

Source: Allison, E.H. *et al.* (2005). Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor. DFID Fisheries Management Science Programme Project R4778J, UK. www.fmsp.org.uk

UNCERTAINTIES IN CLIMATE CHANGE IMPACTS

Although there is increasing awareness of the potential risks of climate change to the fisheries sector and to the livelihoods of the poor in fishing-dependent areas, and there are documented examples of change, many uncertainties remain regarding the nature and scale of future impacts.

More detailed predictions of climate change effects on specific fisheries systems will be needed to determine net changes for fisheries in countries identified as vulnerable. This requires increased spatial resolution of both ocean and land temperature forecasts. Regional rainfall forecasts would help planning and management in river basins. Understanding the potential impact of climate change on poverty will require a better understanding of the contribution of fisheries to poverty reduction, and better data on the number of people reliant on small-scale fisheries.

Not all climate change impacts will necessarily be negative. Redistribution of fish stocks may mean that one country's loss is another's gain. The world's fishing fleet is mobile, markets for many fishery products are global and management systems such as access agreements and internationally traded quotas increasingly facilitate adaptation. In this dynamic context, countries and firms with greater resources and adaptive capacity will gain most from positive changes. Poorer countries and people might still be vulnerable – to missing out on benefits of positive change.

GAINS OR LOSSES FOR FISHERIES FROM PREDICTED CLIMATE CHANGE?

Declining winter and spring snow cover over Eurasia is causing a land-ocean thermal gradient favourable to stronger southwest (summer) monsoon winds over the Arabian Sea. This is leading to an increase in upwelling of nutrient-rich waters and an increase in phytoplankton production of over 300 percent was observed from 1997 to 2004. This may benefit pelagic fisheries production, or may cause fish kills and affect benthic fish production due to the harmful effects of more frequent algal blooms.

Snow and glacier melt in the Eurasian mountains (including the Himalaya) may also result in changes in the flows of the Indus, Brahmaputra, Ganga and Mekong, which sustain major river and floodplain fisheries, as well as supplying nutrients to coastal seas. Predictions for consequences of flow regimes are uncertain but increased run-off and discharge rates during this process may boost fish yield through more extensive and prolonged inundation of floodplains. In Bangladesh, a 20-40 percent increase in flooded areas could raise total annual yields by 60 000 to 130 000 tonnes. These potential gains may be counter-balanced by greater dry-season losses due to lower dry-season flows and greater demands on water resources for irrigation, threatening fish survival and making them more susceptible to capture. Damming for hydropower, irrigation and flood control may also offset any potential fishery gains.

Sources: Goes, J.H. *et al.* (2005). Warming of the Eurasian landmass is making the Arabian Sea more productive. Science 308: 545-547.
Allison, E.H. *et al.* (2005). Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor. DFID Fisheries Management Science Programme Project R4778J, United Kingdom. www.fmsp.org.uk

COPING WITH CLIMATE VARIABILITY AND CHANGE

Greater understanding of how people cope with and adapt to fisheries with extreme natural variations would assist in developing adaptation strategies to the additional impacts of future climate change. The relative risk of climate change on fisheries sectors also need to be understood in the context of impacts on other natural resource sectors and on other hazards that result in high levels of poverty, including food insecurity, epidemic disease, conflict, political marginalization, inequity and poor governance.

Diverse and flexible livelihood strategies

Fishing communities have often developed adaptation and coping strategies to deal with fluctuating environmental conditions.

FISHERY	INDIVIDUAL AND HOUSEHOLD ADAPTIVE STRATEGIES AND COPING RESPONSES
Coastal artisanal fisheries for small pelagic species West Java, Indonesia	**• on the south Java coast, individuals switch between rice-farming, tree-crop farming and fishing in response to seasonal and interannual variations in fish availability • full-time fishers from the north coast (Java Sea) villages track seasonal and spatial variation in fish stock availability with longshore and inter-island migrations**
Ansa Chambok, Great Lake (Tonle Sap) area, Cambodia	**• livelihoods are sustained by use of both private and common property, including fisheries resources, with intra-household division of labour to optimize complementary livelihood activities • production activities in one environment are subsidised by inputs supplied by other environments**
Coastal artisanal Fisheries, Galicia, northeast Spain	**• diverse pattern of fishing activities with respect to the species exploited, location of fishing grounds and gear used •seasonal fishing supplements incomes of a range of people – e.g. retired persons, taxi drivers, shopkeepers, the unemployed**
Lake Victoria, Kenya	**• "Fishing and farming [and livestock herding] have become inextricably linked over many generations in the overall objective of achieving household nutritional security … In a typical year, oscillations occur between the components of this tri-economy"**

Source: Allison, E.H. and Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. Marine Policy 25: 377-388

Flexible and adaptable institutions

Co-management approaches to fisheries can benefit local communities by giving them more control over their resources. However, if new institutions for management are not based on an understanding of livelihoods and of current coping strategies, they can increase communities' vulnerabilities to climate variability. Traditional institutions (rules, customs, taboos) in climate-sensitive environments have tended to be flexible, to accommodate the impacts of climate variability.

FISHERY	INSTITUTIONAL AND REGULATORY - STRATEGIES AND RESPONSES
Reefs and atolls, Palau, Micronesia	**• land and sea tenure are integrated • fishing in inland lagoons is limited to when bad weather prevents fishing in the open sea a • flexible redistribution of fishing rights among neighbouring municipalities, according to needs and surpluses • access, in times of local scarcity, to neighbouring community-controlled fishing grounds in exchange for part of the catch**
Subsistence fisheries of the Cree, northern Canada	**• no rigid territorial system, thus allowing greater flexibility in catch distribution and maximizing the yield • gear limited to small units to maintain mobility**
Peruvian sardine and anchoveta fisheries	**• improved El Niño forecasting services, accessible to all • government fishing bans in periods of resource scarcity, to aid recovery of stocks during favourable climate conditions**

Sources: Allison, E.H. and Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. Marine Policy 25: 377-388.
Broad, K., Pfaff, A.S.P., and Glantz, M.H. (2002). Effective and equitable dissemination of seasonal-to-interannual climate forecasts: policy implications from the Peruvian fishery during El Niño 1997-98. Climatic Change 54: 415-438.

NORTHERN NIGERIA: VARIABLE ACCESS RIGHTS TO DEAL WITH A VARIABLE CLIMATE

The Nguru-Gashua Wetlands in Northern Nigeria are an important source of fisheries resources for surrounding villages. During the flood season there is an open access regime to the river fisheries. When the floods recede the deep sections of the river are managed by village water management councils. Fishers either pay for the right to use the deep sections or give up part of their catch to the council; outsiders must seek permission. River sectors are fished one at a time in rotation. Floodplain pools are owned by individuals or families, who must also give up some of their catch to the village which uses the proceeds for community development projects.

Source: Neiland, A., E. Madakan, D., Bene, C. *et al.*, (2005). Traditional management systems, poverty and change in the arid zone fisheries of northern Nigeria. Journal of Agrarian Change 5: 177-148.

Risk reduction initiatives

Risk reduction initiatives seek to address vulnerabilities through early warning systems, disaster recovery programmes and reducing risk exposure by enhancing coastal and flood defences, including natural ones that also help to enhance ecological resilience. Where storms and flooding are relatively regular and able to be somewhat advisable (e.g. the tropical hurricane and monsoon belts), communities commonly take preparative action and organize sufficiently to restore key services and economic functions.

BENEFITS FOR FISHERIES THROUGH DISASTER PROTECTION AND EARLY WARNING SYSTEMS

SRI LANKA: Natural barriers such as sand dunes, mangrove forests and coral reefs dampened the energy of the Indian Ocean tsunami waves helping to protect some coastlines from their full impact. This applies more commonly for storm damage and, throughout Asia, deforestation of mangroves and reef damage has removed natural storm barriers potentially making coastal livelihoods more vulnerable.

VIETNAM: The Red Cross has assisted coastal communities to replant mangrove, improving physical protection from storms. This has reduced the cost of maintaining coastal defences (dykes) and saved lives and property during typhoon seasons. Mangrove restoration has also improved fisheries livelihoods through the harvesting of crabs, shrimps and molluscs.

BAY OF BENGAL: Fishermen receive up-to-date weather forecasts and severe weather warnings via mobile phone messages, reducing the number of vessels caught at sea by typhoons.

Sources: Adger, W.N. *et al.* (2005). Social-ecological resilience to coastal disasters. Science 309: 1036-39.
International Federation of Red Cross and Red Crescent Societies. World Disasters Report: Focus on Reducing Risks. Geneva, 2001.
Fishermen on the net. The Economist, 8 November 2001.

Planned adaptation

National Adaptation Programmes of Action (NAPAs) are being funded by the World Bank/ United Nations Environment Programme Global Environment Facility to address the urgent national needs of least developed countries (LDCs) for adapting to the adverse impacts of climate change. Coastal and fishery sector management plans are often only partly considered, frequently due to lack of appropriate knowledge on the sector.

It has been increasingly recognized that reducing the vulnerability of fishing communities as a whole can help address poverty and resource degradation, and enhance adaptive capacity to a range of shocks, including those resulting from climate variability and extreme events.

NATIONAL ADAPTATION PROGRAMMES OF ACTION (NAPAs)

Guyana has completed a National Climate Change Adaptation Policy and Implementation Plan. This identifies potential climate change threats to fisheries including the impacts of increased flooding and sea level rise on infrastructure, and potential negative impacts on mangroves – a vital habitat supporting the shrimp export market. However, adaptation strategies focus on coastal management without specific attention to the fisheries sector. Since coastal erosion is a particular concern in Guyana, adaptation strategies to this problem might be planned that are detrimental to the fisheries resources.

Bangladesh has also drafted a NAPA and held a National Stakeholder Consultation Workshop to discuss it. The adaptation options for fisheries focuses on aquaculture, but does not consider options for mitigating adverse effects of river floods or droughts on river fisheries.

Source: http://www.undp.org/cc/napa.htm

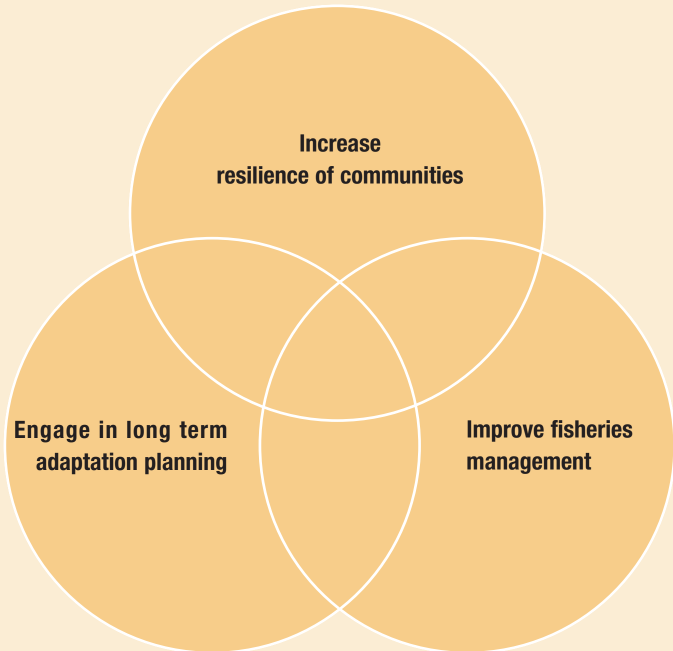
RESPONDING TO THE THREAT OF CLIMATE CHANGE

Human-induced climate change is already happening and whatever measures are taken to slow or reverse these changes in the longer term, we will have to live with the consequences of change within our lifetimes. Despite the uncertainty of climate change impacts on the contribution of fisheries to poverty alleviation, there are opportunities to reduce the potential vulnerability of fishing communities to climate related impacts. Although some communities and fishery management systems already adapt to climate-driven fluctuations, there are doubts that, with other pressures on natural resources and on community function, existing adaptive capacity will be sufficient to respond to additional vulnerability resulting from global climate change.

Policy actions fall under two domains: mitigation and adaptation. Our focus on adaptation in this policy brief does not imply that mitigation of climate change (reducing C02 emissions to slow or reverse global warming) is unimportant or irrelevant to fisheries. The world's marine fishing fleets are estimated to burn 1.2 percent of global annual fuel-oil use, so its potential contribution to mitigation is fairly minor, though every contribution can be important and additional energy savings may also be made elsewhere in the sector. There may also be synergies between emission reductions, energy savings and responsible fisheries. For example, policy support for the following measures could contribute to all these goals:

- raising awareness of the impacts of climate change, to ensure that the special risks to the fishery sector are understood and used to plan national climate change responses, including setting of mitigation targets through mechanisms such as the Kyoto Protocol;
- reducing fuel subsidies granted to fishing fleets, to encourage energy efficiency and assist towards reducing over-capitalization in fisheries;
- supporting the use of static-gear – pots, traps, longlines and gillnets, which uses less fuel than active gear such as trawls and seines – and therefore emits less CO_2;
- restoring mangroves and protecting coral reefs, which will contribute to CO_2 absorption, coastal protection, fisheries and livelihoods;
- managing aquaculture to optimize carbon retention, reduce energy use and minimize impacts on mangroves and other important habitats; and
- raising awareness through seafood campaigns, reducing food miles, and promoting corporate social responsibility in the commercial sector.

CLIMATE CHANGE MITIGATION



Source: Tyedmers, P.,Watson, R., Pauly, D. (2005). Fuelling global fishing fleets. AMBIO: Journal of the Human Environment. 34(8):635-638

ADAPTATION

While mitigation issues are valuable, the challenge of adaptation is both significant and potentially urgent. Policy support for adaptation involves supporting measures to reduce exposure of fishing people to climate-related risks, reducing dependence of peoples' livelihoods on climate-sensitive resources, and supporting people's capacity to anticipate and cope with climate-related changes.

Ministries and other national-level and international stakeholders responsible for fisheries management can:

• Conduct climate-change risk assessments and allow for the costs of adaptation and the potential changes in economic contributions from the fishery sector under likely climate scenarios.

• Support initiatives to reduce fishing effort in overexploited fisheries. Lightly-fished stocks are likely to be more resilient to climate change impacts than heavily-fished ones.

• Build institutions that can consider and respond to climate change threats along with other pressures such as overfishing, pollution and changing hydrological conditions. This requires integrating research and management across these sectors and ensuring that regulations limiting access to resources are sufficiently flexible to respond to both the threats and benefits of future climate variability.

• Establish institutional mechanisms to enhance the capacity of fishing interests (fleets, processing capacity, quota ownership) to move within and across national boundaries to respond to changes in resource distribution. This implies developing bilateral and multilateral agreements. This can only be recommended in the context of functional transboundary fishery governance regimes and effective systems to control illegal, unreported and unregulated fishing.

• Link with disaster management and risk reduction planning, especially concerning planning coastal or flood defences; apply 'soft engineering' solutions where possible – conservation of natural storm barriers, floodplains, erodable shorelines to manage costs and damage impacts.

• Enhance resilience of fishing communities by supporting existing adaptive livelihood strategies and management institutions that are designed to support adaptation to climate change and variability, such as reciprocal access arrangements.

• Address other issues contributing to the vulnerability of fishery sector communities such as access to markets and services, political representation and improved governance.

• Engage in long-term adaptation planning, including promotion of fisheries related climate issues in Poverty Reduction Strategy Papers and National Adaptation Programmes of Action–, to address longer-term trends or potential large-scale shifts in resources or ecosystems.

NGOs and community-based organizations can:

• Identify the current and future risks, potential impacts and resilience/recovery mechanisms within communities, and engage communities together with governmental and non-governmental agents in preparedness planning.

• Communicate to policy-makers the importance of fisheries for poverty alleviation and the risks of climate change.

• Build and support the resilience of coastal and other fisheries communities by supporting community-level institutional development and vulnerability reduction programmes.

• Support risk reduction initiatives within fishing communities, including conservation of natural storm barriers (reefs, mangroves, wetlands), warning systems, preparation measures and recovery processes.

Adaptation planners, donor organizations and economic analysts can:

• Assess overall range, combination, likelihood and potential impacts of climate related effects in fishery contexts.

• Assess risks of future fish stock variation and likelihood of resource collapse and produce sectoral and food security plans accordingly.

• Assess specific cross-sectoral factors which will increase or decrease impacts and adaptation potential in fishing communities.

• Incorporate fisheries issues within National Adaptation Programmes of Action for Least Developed Countries.

RESOURCES

This policy brief has been developed on the basis of the following report:

Allison, E.H., Adger W.N., Badjeck M-C., Brown, K., Conway, D., Dulvy, N.K., Halls, A., Perry, A. and Reynolds J.D. (2005). Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor: analysis of the vulnerability and adaptability of fisherfolk living in poverty. Fisheries Management Science Programme Project No. R4778J. MRAG, London. http://www.fmsp.org.uk

Climate change

Center for International Earth Science Information Network (CIESIN), Columbia University, New York. http://www.ciesin.org/
FAO Climate Change pages. http://www.fao.org/clim/default.htm
IGBP (2003) Marine Ecosystems and Global Change. Global Ocean Ecosystem Dynamics (GLOBEC). IGBP Science Reports No. 5, 34 pp. http://www.igbp.kva.se
Intergovernmental Oceanic Commission (UNESCO). http://ioc.unesco.org/iocweb/climateChange.php
Intergovernmental Panel on Climate Change (IPCC). http://www.ipcc.ch
Science and Development Network. Dossiers: Climate Change. http://www.scidev.net/dossiers/
Tyndall Centre for Climate Change Research. http://www.tyndall.ac.uk/index.shtml
UNDP Climate Change pages. http://www.undp.org/climatechange/
UNEP Climate Change Network. http://climatechange.unep.net/

Climate and fisheries

FAO. (2006). Fisheries and Global Climate Change http://www.fao.org/figis/servlet/topic?fid=13789
Glantz, M.H., editor. (1992). Climate Variability, Climate Change and Fisheries. Cambridge University Press.
OneFish iInformation portal. http://www.onefish.org [Topic on Economic Impacts of Climate Change]
Sharp, G. (2004). Future climate change and regional fisheries: a collaborative analysis. Fisheries Technical Paper 452, FAO, Rome.
WWF. (2005). Are We Putting Our Fish in Hot Water? WWF Climate change Programme. http://assets.panda.org/downloads/fisherie_web_final.pdf

Climate change, adaptation and poverty reduction

Adger, W.N., Huq, S., Brown, K., Conway, D. and Hulme, M. (2003). Adaptation to climate change in the developing world. Progress in Development Studies 3(3): 179-195.
IISD, IUCN, SEI, Intercooperation. *et al*. (2003). Livelihoods and climate change: combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty. IISD Publications. http://iisd.org/publications/publication.asp?pno=529.
World Bank and ten other international development and environment agencies. (2003). Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation. World Bank, Washington, DC. 43 pp. http://lnweb18.worldbank.org/ESSD/envext.nsf/46ByDocName/KeyThemesVulnerabilityandAdaptationPovertyandClimateChange

For more information, contact:

SFLP Coordination Unit

Sustainable Fisheries Livelihoods Programme
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla, 00153 Rome, Italy
E-mail: SFLP-PCU@fao.org

This series of policy briefs, produced by
The Sustainable Fisheries Livelihoods Programme,
explores new directions and partnerships
in addressing fisheries and development issues

This brief was developed by
the DFID/FAO Sustainable Fisheries Livelihoods Programme (www.sflp.org)
in collaboration with
Projects No R4778J and R8475 of the DFID Fisheries Management Science Programme (www.fmsp.org.uk)
assisted by staff of
the Overseas Development Group, University of East Anglia, Norwich, United Kingdom of Great Britain and Northern Ireland (www.uea.ac.uk/dev/odg)
the Marine Resources Assessment Group (www.mrag.co.uk)
the FAO Fisheries and Aquaculture Department (www.fao.org/fi/default.asp) and the FAO Interdepartmental Programme on Climate Change and Food Security (www.fao.org/clim/default.htm)
the Centre for Environment, Fisheries and Aquaculture Sciences (www.cefas.co.uk/Lowestoftlab.htm)
the Tyndall Centre for Climate Change Research (www.tyndall.ac.uk/)

To cite this publication:
FAO. 2007. *Building adaptive capacity to climate change. Policies to sustain livelihoods and fisheries*. New Directions in Fisheries – A Series of Policy Briefs on Development Issues. No. 08. Rome. 16 pp.
Also available from: http://www.sflp.org/briefs/eng/policybriefs.html

ISSN 1817-2679