

CLIMATE CHANGE & FISHERIES WORKSHOP

**Impacts of climate change on fisheries and
interactions with other natural resource sectors**

12TH SEPTEMBER 2005

UK Department for International Development
(DFID)



DFID Department For
International
Development



Cefas



UEA
NORWICH

MRAG
Marine Resources Assessment Group

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1. INTRODUCTION

A workshop was held at DFID on 12th September to look at *Climate change, Fisheries and Poverty Reduction: Impacts of climate change on fisheries and interactions with other natural resource sectors*.

This formed part of a Fisheries Management Science Programme (FMSP)¹ project aimed at promoting new knowledge on climate change and fisheries².

The overall aim of the project is to increase awareness of the issues to a range of stakeholders ranging from the climate change sector to fisheries management and risk reduction or disaster management initiatives. Along side the workshop the project is aiming to increase awareness and knowledge through publishing a scientific paper, flyers and policy briefs.

The following objectives were identified for the workshop:

1. Build awareness and share information on the linkages between climate change and poverty reduction through the impacts on the fisheries sector, and interactions with other natural resource sectors, in developing countries;
2. Determine knowledge gaps and areas of uncertainty on the linkages, and how this currently affects decision making.
3. Agree areas of future research, assessment and analysis to understand the impact of climate change on fisheries and poverty reduction.
4. Draw up a synthesis of what is currently known about the scale of the climate change risk on fisheries and poverty reduction; interactions with other natural resource sectors; coping strategies, sources of resilience and limits to adaptation; knowledge gaps; and ways forward to be published by the Sustainable Fisheries Livelihoods Programme (SFLP FAO/DFID) as part of the 'New Directions in Fisheries' policy brief series.

¹ FSMP forms part of DFID's current natural resource research programme which comes to a close in October 2005. DFID's new research agenda identifies climate change adaptation as a key theme.

² See www.fmsp.org.uk Go to Current projects and search under R8475

2. AGENDA

The agenda of the workshop is provided below:

Time	Activity	Speaker/Chair
1000-1005	Opening remarks – DFID’s current interest and approach to climate change	Professor Beddington (Manager of DFID’s Fisheries Management Science Programme FMSP*)
1005-1010	Introduction	Nick Dulvy (Cefas)
	PRESENTATIONS I (15 minutes for talks, 5 min discussions after each talk)	Chair: Nick Dulvy (Cefas)
1010-1030	Interactions of hazard and vulnerability for fisheries	Declan Conway (UEA)
1030-1050	Adaptation research in the Renewable Natural Resources Research Strategy (RNRRS) between 1995-2006	Michael Mortimore (Drylands research)
1050-1110	Climate Change Impacts on Fisheries Production in the Land-Water Interface	Ashley Halls (Aquae Sulis Ltd)
1110-1130	GLOBEC’s views on Fish, Humans and Global change: a not-so-quiet revolution	Manuel Barange (Globec)
1130-1140	<i>BREAK</i>	
	PRESENTATIONS II	Chair: Graham Pilling
1140-1200	OECD case studies on climate change impacts and adaptation	Georg Caspary (OECD)
1200-1220	Current and future coral reef sustainability and food security	Nick Dulvy
1220-1240	Global vulnerability and adaptability of poor fisher-folk to climate change	Eddie Allison (UEA, SFLP/FAO/DFID)
1240-1300	Group discussion: <ul style="list-style-type: none"> • The value and use of current knowledge • Review knowledge gaps & future research needs 	Chair: Eddie Allison
1300-1345	<i>LUNCH</i>	
1345-1400	Instructions for the working group sessions (also see separate working group instructions sheet)	Charlotte Howard (MRAG)
1400-1500	Thematic working group sessions	<i>Facilitators/Rapporteurs</i>
	Group I: Impact pathways	Marie Badjeck/ Nick Dulvy
	Group II: Relative risk of climate change	Eddie Allison/ Graham Pilling
	Group III: Interactions within other resource sectors	Ashley Halls/ Allison Parry
	Group IV: Adaptation: short-term coping and long-term strategies	Declan Conway/Charlotte Howard
1500-1510	<i>BREAK</i>	
1510-1620	Presentations and Group discussion to pull out key recommendations/messages and fill gaps within policy brief	Chair: Charlotte Howard
1620-1630	Concluding remarks and next steps	Nick Dulvy/Graham Pilling

3. PARTICIPANTS

The following participants were present at the workshop.

Name	Email	Organisation
Manuel Barange	m.barange@pml.ac.uk	Globec
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4. PROCEEDINGS

4.1. Opening Remarks – Professor Beddington

Professor Beddington, manager of the Fisheries Management Science Programme (FMSP) under DFID's RNRSS Programme, gave the opening remarks to the workshop.

He described how it is vital to improve fisheries management to ensure the sustainability of fish stocks but also to support fishing communities who are among the world's poor. Fishing communities have been shown to have high HIVAIDS levels and high levels of vulnerability to extreme events. Their vulnerability will be driven further by climate change.

Climate change is likely to result in significant oceanographic changes and the change in stock distributions, which may be difficult for communities and economies to cope with. Professor Beddington suggested that we need to bring together social sciences and fisheries management and look at how fishing communities cope with variability, and how climate change will increase this variability and levels of uncertainty.

4.2. Introduction Remarks – Nick Dulvy

Nick Dulvy from CEFAS gave the introductory remarks to the workshop. He described how the impacts of climate change will be significant on river, coastal, offshore and lake fisheries. He remarked that the workshop is covering a wide set of issues, particularly as there are considerable interactions with other resource sectors to consider. He then concluded that no one person can cut across all these themes but we can use the opportunity of this workshop to bring different sets of expertise to address the issue.

Nicky also summarised the aims of the workshop:

- Build awareness and share information
- Map out knowledge gaps
- Prioritise knowledge gaps and determine areas for future research
- Provide information that will be distilled into an SFLP policy brief

4.3. Presentations

The following presentations were given during the workshop and are provided as attachments to this report.

Presentation	Speaker	Talk
Interactions of hazard and vulnerability for fisheries	Declan Conway (UEA)	1
Adaptation research in the Renewable Natural Resources Research Strategy (RNRSS) between 1995-2006	Michael Mortimore (Drylands research)	2
Climate Change Impacts on Fisheries Production in the Land-Water Interface	Ashley Halls (Aqua Sulis Ltd)	3
GLOBEC's views on Fish, Humans and	Manuel Barange	4

Global change: a not-so-quiet revolution	(Globec)	
OECD case studies on climate change impacts and adaptation	Georg Caspary (OECD)	5
Current and future coral reef sustainability and food security	Nick Dulvy (CEFAS)	6
Global vulnerability and adaptability of poor fisher-folk to climate change	Eddie Allison	7

4.4. Questions and Answers following presentations

Comments/Questions	Responses
<i>Talk 1: Interactions of hazard & vulnerability for fisheries (Declan Conway)</i>	
Jo House – NERC Quest - We need to remember the potential threat of ocean acidification	Climate change one of many drivers – will interact with other drivers in the global system. We therefore need to understand the full system.
<i>Talk 2: Adaptation research in the Renewable Natural Resources Research Strategy (RNRRS) between 1995-2006 (Michael Mortimore)</i>	
Declan Conway: Have you observed a large climate signal – or is it submerged in the noise of other risks/issues?	It is a bit too early to look at clear signals, but confident that these will emerge.
Sallemul Huq - Did any of the projects come up with climate change as an area of vulnerability or future research need?	There are some conscious reference to climate change risk and vulnerability, but most researchers have found climate change is marginal to responding to DFID's poverty focussed livelihoods approach. There is a need to look at adaptive capacity in a more analytical way.
<i>Talk 3: Climate Change Impacts on Fisheries Production in the Land-Water Interface (Ashley Halls)</i>	
Eddie Allison – given complexity and looking at net effects. Are there any river basins or coastal areas that we can say it will be negative or positive outcome or is it uncertainty in the magnitude?	We have developed models to predict the impacts of increasing water levels for river fisheries but no models to determine negative impacts, particularly in the dry seasons. It is therefore not possible to say at this stage whether there is an overall positive or negative impact.
<i>Talk 4: GLOBEC's views on Fish, Humans and Global change: a not-so-quiet revolution a not so quiet revolution – Manuel Barange</i>	
Tim Bostock – California anchovies data series illustrates a high level of variability over time without the impacts of climate change. Can the peaks illustrated in recent phytoplankton records be explained as natural variation? over many anchovies – large variability How can you say that phytoplankton peaks are not caused by natural variation?	The peaks in anchovy populations in California can be explained by 65 years earth rotation. The phytoplankton peaks are higher than those caused by natural variation and do not occur in areas of natural flow. Warming of the oceans is causing a decline in the circulation.
<i>Talk 5: OECD case studies on climate change impacts and adaptation – Georg Caspray</i>	
Friday, Njaya: How can you define short-term, medium and long-term?	Response: Short term – 2-5 years Medium term – decades Long term - +50 years
<i>Talk 6: Impacts of Climate Change on food production of coral reefs – Nick Dulvy</i>	
Caroline Sullivan: What is the basis of the	Nick Dulvy – E.g. Losing ½ - 1.5 reef in

assumption that climate change will depress ecological services	<p>Caribbean by year Factored in rates of reef loss – assumes direct relationship death of reef and reduction in fish population</p> <p>Mirrored by findings of Millennium Ecosystem Assessment that ecosystem services will diminish with climate change. However climate change is not the only driver: population is 5x the problems than climate change.</p>
Caroline Sullivan: Is it possible there could be a geographical shift?	Yes but outside development time-frame.
Elizabeth Tyler: Will climate change have more immediate impact on coral reef fisheries than pelagic fisheries?	Impacts on fish populations still unknown for tropical fisheries.
Emily Corcoran: Recent research by Charles Shepherd has shown that when bleached corals die they retain their complex structure for a time afterwards, but this is then weakened by bio erosion. The reef begins to break down effectively increasing the depth of the water column above the rubble that is left dubbed 'pseudo sea level rise'. If 'real' sea level rise is added to this, and without the structure of the reef, shorelines may become increasingly vulnerable.	
<i>Talk 7: Global vulnerability and adaptability of fisher-folk to climate change: Eddie Allison</i>	
Michael Mortimore – What is your view on targeting? Should we use the global risk analysis method or look at important river basins?	<p>The Global risk analysis helps us focus down to places where there are important fisheries but also where they play important roles in economies.</p> <p>It will be important to understand the use of a fishery – whether it is livelihoods or national budgets for development spending. Targeting will then depend on the donor policy – whether this is to assist livelihoods or maximise revenues. It will also be important to understand at what level increased revenues will make a difference.</p> <p>In terms of using the global risk or the river basin approach it would make sense to select areas that where these coincide.</p>
Manuel Barange: Peru appears on the vulnerability list but is not as high as you might expect. Is this because fisheries is more of a commodity than a food source?	The main potential bias of the analysis is due to scaling and averaging across the different indexes. Peru's fisheries are highly sensitive to climate change but have a higher capacity to adapt and therefore a lower vulnerability.

	In future it may be useful to illustrate all the different indices separately rather than averaging them into a single vulnerability index.
Nick Dulvy – it was planned to include catch value into the analysis but this data was not available.	
Caroline Sullivan – is it possible to use other indicators other than FAO data to measure poverty in small-scale fisheries. FAO statistics can be misleading, for example in the water sector FAO stats only record irrigated agriculture.	<p>It is true that FAO statistics are not 100% reliable. For example, inter-regional trade is not often recorded</p> <p>However countries are asked to give an estimate of the contribution of small-scale fisheries to their national fisheries– based on frame surveys (e.g. number of canoes)</p> <p>In addition SFLP is looking at the real economic contribution of fisheries to West African countries, and this may also give another helpful indication.</p>
Tim Bostock: An important issue is the value of fisheries resources to small-scale operations. FAO statistics focus on commercial fisheries, and we therefore undervalue ecosystem services and functions. We need better information on fisheries in order to convince policy makers that they are an important resource. To do this we can calculate potential rents from the resource and see what can be done with these rents. DFID’s focus it to support developing countries fisheries in understanding the value of their fisheries and how they can make better use of that value.	
Saleemul Huq: A large number of countries that come out as vulnerable in the global analysis are from the Least Developed Countries (LDCs). There is a LDC fund to support 48 countries to carry out National Adaptation Programmes of Action (NAPAs), and this will be taking place over the next 6 months. Bangladesh has produced a NAPA and fisheries did come up as an issue. It will be interesting to see if this is the same for the other countries.	
Manuel Barange – if we lack information on small-scale fisheries– should DFID put money into basic information collection?	
Ashley Halls – FMSP (funded by DFID) is supporting a project to provide a series of guidelines for collecting information.	

Tim Bostock – DFID focus is on international policy. There is little funding for large scale programmes, but DFID can contribute by working with other development partners to influence their spending patterns.

5. WORKING GROUPS

This section summarises the outputs from the working groups. Instructions for the working groups are provided in Annex 1.

5.1. Group 1: Impact Pathways

Task 1: Impacts on temporal scale

This task involved reviewing climate change impacts on fisheries along a temporal scale. The following additions/changes were suggested:

Have all the potential impacts been covered?

- Irreversible changes – should also include SLR/inundation, ocean acidification, glacial and polar melting – and some of these are occurring now
- Other specific issues to include are – shifts in position of upwellings and timing of natural events
- We have a good understanding of how some things will play out for the plankton communities, but not necessarily how those effects will carry over to fish, fisheries, socio-economic impacts
- Wind-driven upwellings could change latitude. Up-welling fisheries particularly sensitive e.g. Peru, Namibia. Small pelagics dominate some fisheries in Africa, Asia – we know little re. how climate change will play out for these types of fish. Distribution of fish stocks could shift across national boundaries
- Increased probability of extreme events
- Timing in phenology
- Changes in rainfall affecting hydrological changes to rivers
- SLR affecting coastal habitats and exacerbated by development

Are timings of impacts appropriate?

- 5 years too short re. extreme events
- ENSO, PDO, NAO – somewhere between 2-3 and 10 years
- Manuel's point that seasonal and climatic variation should also decadal cycles of variation, production – such as NAO, PDO

It might be possible to change table structure to reflect risk analysis approaches – i.e. frequency and magnitude of events

	2-3 years	5 years	10 years	20-50 years
Variability	Seasonal/inter-annual e.g. El Nino affects: - up-welling - distributions		Cyclical decadal events e.g. NAP, PDO affects: - production cycles	
Regime shift				
Extreme events				
Irreversible	Glacial melts			Sea level rise

changes				Inundations of river deltas Acidification Loss of glacial melt-waters Loss of polar ice
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Task 2: Impacts pathway across ecological and social systems

Climatic changes	Physical impacts	Impacts on fish	Impact on ecosystems	Social outcomes	Economic outcomes
CO2 rise	acidification/pH	dissolution of calcium carbonate – depth of lysocline	change in speciation of plankton Affects coccolithophores, reefs. Plankton effect – high impact, low certainty	Reefs – reduced barriers to wave action – storm events greater, reduction in productivity	More flooding. Potential for fisheries impacts re. plankton
increased storminess warming			changes in productivity – mainly at high latitudes		may primarily be a problem for high latitude countries
warming			shifts in upwellings – distribution, productivity	Social systems need to adapt to changes.	Changes to fishing industry – poor, dependent people – including women.
warming				new aquaculture ventures - negative	

Task 3: Review of exercise

Are impact pathways important to understand?

- Yes – but we wondered about the relative importance of understanding these for different groups?

Key messages based on current knowledge that come from this exercise?

- Some pathways very poorly known, others are well known (e.g. SLR)
- Need to consider who will we target to make the point to politicians and policy makers about range of possible impacts – e.g. that it's not just about e.g. SLR
- Current knowledge is limited to specific systems, sites – can be extremely difficult to extrapolate beyond our knowledge
- There is a disconnection between disciplines and a need for better communication

Further info to illustrate these key messages?

- Royal Society brief – Ocean acidification, also on changing crops (other resource sector)
- Encouraging that some development agencies are starting to focus on climate change issues (e.g. Oxfam) – now a consortium of development NGOs looking at climate change (led by IIED) – recognition of importance
- QUEST – 1. development of Earth System Model – model that brings in ecosystems and human dimensions – still a big unknown how to bring these in, how to bring in social science and economics – unclear how to do it within the same framework.
- Working group that Michael's involved with that's looking at issues related to Wetlands and Livelihoods – with a strong emphasis on applied work
- International level work – scientific (not socio-econ) e.g. SOLAS, GLOBEC (e.g. Clitop)

What are the gaps in understanding?

- Specific pathways of impact for many issues
- Cross-sectoral understanding in developing adaptation strategies – need for better communication, understanding across disciplines
- Biggest issue – rainfall patterns – definitely re. freshwater. Increased resolution of models over land would be very useful – but it's the hardest thing to predict. This is likely to improve – if people can pin down what's going to happen with the circulation (e.g. jet stream), then will be better able to predict this. Most important areas – e.g. Sahel – very hard to model.
- Knowing how changes in phytoplankton are going to play out across systems
- UV radiation – also affects plankton species, could change community composition
- Under a changed climate – changed pattern of dust distribution. Ocean is iron-starved, so where dust falls with wind and ocean circulation, then iron fertilises and changes productivity – another irreversible change for Table 1 (long-term, affects species of plankton... so eventually will affect fisheries) – maybe 20-50. Will affect drying non-fisheries countries
- Tropical systems – limited knowledge in comparison with temperature systems
- Southern ocean – least known re. circulation, but likely to be significant changes

What type of research is most appropriate?

- Great value of studying adaptation to past events, environmental change, variability.
- Identifying measurable 'well-being' /poverty indicators which actually are appropriate to people in fisheries – ones which will actually allow for examining whether there are changes.
- May also be scope for thinking about climate change impacts beyond poverty – e.g. cultural impacts may be a priority in some places

Cross-sectoral issues

- Desertification
- Land-use changes – irrigation, fertilisers, changes in fishing pressure re. protein from other sectors,
- Water industry – ministries of water resources powerful, and not necessarily communicating with fisheries – e.g. dam impacts – fisheries, agriculture. South Africa – ecosystem approach to water distribution.

5.2. Working Group 2: Relative Risk

Climate Factors

Issue	Likelihood		Severity		Ease of adaptation	
	W Africa	Indonesia	W Africa	Indonesia	W Africa	Indonesia
Extreme events	Low	High	High	High	Medium Disaster preparedness	
Sea level rise	Medium	Medium	Medium	Medium	Low	Low
Stock prodn/distribution	High	High	High	Medium (area)	Low Migration	
Critical habitat loss	High	High	High	High	High Reduce other stresses	
Rainfall change	High	High	High	High	Integrated water resource mgmt	
Increased irrigation	High	High	High	Medium		

Other factors

Issue	Likelihood		Severity		Ease of adaptation	
	W Africa	Indonesia	W Africa	Indonesia	W Africa	Indonesia
HIV/AIDS	High	High	High	High	Funding, education, behaviour	
Governance weakness	High	High	High	High	Difficult!	

Review of Task

- Climate risks fit in with other risks that may be of equal or higher importance of defining vulnerability
- Attempts to develop a hierarchy of risks may lead to climate change falling low in priorities
- Considered expensive to deal with compared to HIV/AIDS, malaria or conflict
- There is therefore a risk of promoting climate change in this context

Key messages

- Look at prioritisation exercises and try not to get drawn into narrow cost-benefit exercise

Further information

- There are other fields of work that fisheries has not made use of e.g.– from environmental and social risk literature.

Gaps in understanding

- Understand how people perceive risks? Where does climate fit in these perceptions? For fishers and fishing managers.
- Combine objective view of risks and perceived risks
- Need to deal with these perceptions

Future research

- Look at risk factors identified here
- Look at what people think is important

What type of research most important

- Multi-disciplinary work useful in this context
- Objective understanding of risk combined with perception of risk
- Vulnerability context
- Importance of placing risk exposure in long-term context

5.3. Working Group 3: Interactions across sectors

- Rather than mapping out all possible interactions, it is more important to highlight the significance of these interactions using case study examples to influence policy makers.

CC IMPACT	Fishing	Farming	Forestry	Livestock	Aqua-culture	Energy	Water for human use
1. Decreased rainfall	-(inland) reduced water levels in lakes and rivers, decreased productivity -(coastal) increased salinity in deltas,	-Increased pressure on irrigation water sources	-change in species composition -increased risk of fires-impact on sp. productivity	-lack of drinking water affects milk production -increased mortality -increased vulnerability to diseases			
Examples	Lake Chilwa, L.Chad Nile Delta, Indus Delta	Sub-saharan Africa, early 1990s drought	Spain & Portugal fires, Zimbabwe WorldBank study reduction of woody biomass				
Adaptive strategies and impact on fisheries	-change target species -move to other sector	-extraction of increasingly scarce water will have negative impacts on fisheries	Different adaptation strategies for Plantation vs natural forest -limit extent of commercial plantation forestry-				

		through reduced water levels and water quality	provide water for maintenance of national park natural forests				
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Conclusions of Group 3 discussions:

- Indirect impacts are likely to be significant.
- It is essential that the impacts of climate change must consider direct and indirect impacts arising from adaptation strategies and interactions between sectors.
- Adaptive strategies should not be planned in isolation in one sector only, nor for one country only (cross boundary issues can be significant).
- Multi / cross sector adaptive strategies will be required.
- Assessments of indirect impacts should aim to take full account of costs across all sectors.
- Issues need to be analysed along the different scales and across the different sectors
- The climate change adaptation process will occur within the ecosystem (eg changes to species assemblages, or production), by users (eg changes to exploitation behaviour, alternative livelihoods), management (of the resource) and policy (that affects management and planning).
- These process will occur on different timescales and spatial scales which must be taken account of when developing multi-sector adaptive strategies.
- Very complex but necessary process – consideration must be given to impacts, adaptations, impacts of adaptations through space and time.
- Currently discussing the development of these themes – group planning to prepare a short paper to feed into existing reviews and policy brief.

5.4. Working Group 4: Short term coping and long-term adaptation

Definitions:

Coping: immediate responses e.g. Food security, Disaster management

Longer-term adaptation: long-term planning

The distinction is often not clear e.g. OECD Case studies

CASE STUDY 1: Cote D'Ivoire

Impacts

- May be impacted by lagoon levels and how this affects fisheries production

Cote d'Ivoire	Short-term coping	
	Longer-term adaptation	Diversification Cooperation between different sectors/groups

Comments:

- Weaknesses of case studies/exercise is to look only at climate. If look at all the other risks e.g. price fluctuation may be a 'double-whammy'

- Important to look at the 'entry' and the 'exit' barriers to fisheries e.g. people that have invested in the fishery
- Dynamic situation: need to understand the reliance on fisheries before you can think of the impacts or the adaptation options.
- Interesting to know how many small-scale fishers are full-time and part-time
- If you have a diverse range of people with different levels of investments you need to be able to design policies that support the full range of livelihoods.

CASE STUDY 2: MALAWI

<i>Malawi</i>	<i>Short-term coping</i>	<ul style="list-style-type: none"> - Mobility – follow fish catches - Good information on fish resources - Set of reciprocal arrangements between migratory and
	<i>Longer-term adaptation</i>	<ul style="list-style-type: none"> - Official recognition of migration - Don't invest in long-term assets due to migratory behaviour - Diversification - Institutional change

- Migrants are mostly full time fishers
- Residents are agriculturalists and are involved in fishing. Migrants employ residents especially in lean agricultural years. To be accepted in the community, migrant fishers need to pay a contribution to local
- Mobility does constrain long-term build up of assets. Do not have assets to rely on e.g. if fisheries collapses.
- There appears to be a trade-off between migrating and diversification.

Other examples of coping:

- Malawi – invest in cheap gears as they know that in 10 years the lake will dry up

CASE STUDY 3: NORTHERN NIGERIA

- Open access during flood period
- During dry-period – controlled by local groups.

<i>Northern Nigeria</i>	<i>Short-term coping</i>	<ul style="list-style-type: none"> - Rely on other people within the community - Access right regime – depending on the water level
	<i>Longer-term adaptation</i>	<ul style="list-style-type: none"> - Part of fisheries are migratory – can exclude or include migratory groups - Increased urbanisation – move to cities - Balance between agriculture and fisheries system - Rely on government for public amenities

Other shocks:

- It is mentioned that there is a lack of water
- Agricultural pests

Climate shifts may be resulting in the following adaptations:

- Rely on better fisheries prices – urbanisation
- New sources of income

CASE STUDY 4: INDONESIA

<i>Indonesia</i>	<i>Short-term coping</i>	<ul style="list-style-type: none">- Diversification- Migration – seasonal movement- Use of jewellery for informal savings/insurance
	<i>Longer-term adaptation</i>	

CONCLUSIONS

- Complex to understand what contributes to vulnerabilities and designing/assisting adaptation
- Could develop a typology of fishing groups:
 - Full time fishers
 - Part time fishers

INFORMATION GAPS

- Long-term weather data
- Impacts of urbanisation – e.g. pollution
- Is diversification really a good idea – e.g. move into urban livelihoods
- How fisheries livelihoods fits into the wider picture. Why are there high levels of poverty? Is it due to migration or due to long-term changes e.g. climatic shifts
- Livelihood analysis to think about links and movement between fisheries
- Expanding analysis to all groups involved in fisheries sector e.g. processors, traders etc.
- Looking at adaptation on a wider-ecosystem e.g. looking at a river basin. If you are looking too small scale you may not see the whole picture
- Making use of Local community predictions and local knowledge of weather/climate
- Understand of the existing situation and perceptions of risk within communities
- Connecting fishing communities and fishing sectors with risk reduction systems
- Increased analytical description of coping strategies

6. RECOMMENDATIONS

6.1. *Research needs*

The following areas for future research were identified by participants:

1) **Data requirements**

Data requirements were identified related to fisheries and climate change.

Fisheries data

- Poverty indicators for fisheries
- Description of livelihoods within fishing communities
- Economic and social contributions of fisheries

It was recognised that there is a lack of information on the importance of fisheries for poverty reduction. This is required to provide policy makers with a stronger justification for prioritising fisheries and considering the potential impacts of climate change. It is also apparent that basic data on fisheries and levels of poverty within fishing communities, particularly small-scale fisheries important to the poor, is missing. This is required in order to understand the vulnerability of fishing communities and the potential risk of climate change. Additional case studies describing livelihoods in fishing communities are needed to understand their overall livelihood strategies and what options are open to them if there are adverse impacts on fisheries production or access.

Climate data

- Prediction of rainfall patterns
- Medium-term weather and climate predictions
- 'Lake-by-lake' predictions

Fisheries are likely to be impacted by changes in rainfall patterns (lake and river fisheries) and changes in wind directions (lake productivity) or ocean circulation (up-welling) but climate change information is currently focused on temperature changes. For planning purposes there is also a need to understand the likely changes in current variability, climate extremes and climate shifts in the medium term, and have predictions for ecological units such as 'river basins', 'lakes' and 'up-welling systems'.

2) **Understanding impacts**

The following research areas were identified in order to have a better handle on the potential impacts of climate change on fisheries:

- Understanding the direct and in-direct impacts, impacts on different temporal and spatial scales and impacts across different resource sectors
- Potential impacts of climate driven ocean acidification, UV radiation, dust depositions and changes in circulation on fisheries
- Impact pathways from changes in phytoplankton to changes on fisheries and fishing communities
- Nature, severity and magnitude of impacts
- Understanding the net positive or negative impacts on fisheries and fishing communities.

3) Understanding risks of impacts for fishing communities

Improved data on vulnerability of fishing communities and the nature of the climate change hazard will assist future risk analyses both on a global scale and on the scale of individual fishing communities.

Global scale comparisons of vulnerability can be useful to raise awareness of climate change risks and to assist targeting, but smaller-scale studies are required for information that can be used in developing or assisting adaptation strategies.

There is also a need to understand people's perception of risk and combine this with objective measures of risk to get a realistic picture of priorities.

4) Understanding adaptation options

- In order to determine ways of supporting adaptation and increasing capacity to cope within fishing communities, there is a need to have a better analytical understanding of current adaptation and coping strategies. This could be based on reviews of coping or adaptation to current climate variability or past changes.
- There is also a real need to ensure that planning for adaptation is undertaken at a cross-sectoral level so that adaptations in one sector (e.g. irrigated agriculture) negatively impacts on fisheries (e.g. river fisheries dependent on water flows).
- The role of natural resources in promoting ecological and human resilience also needs to be taken into account when planning adaptation and further research into this area would provide useful information for planners.
- The relative costs of different adaptation options for fishing communities need to be calculated but also considered on a cross-sectoral level.

6.2. Areas for immediate action

The following areas for immediate action were identified by participants:

Climate change sector:

- Provide climate change predications that include changes of rainfall, wind direction and circulation on a 'river-basin'; 'lake-level' or 'ocean system' to fisheries scientists and researchers

NGOs

- Communicate the importance of fisheries and the risks of climate change to policy makers

Fisheries managers

- Link with disaster management and risk reduction planning especially concerning planning coastal or flood defences, understanding levels of vulnerability and enhancing resilience of fishing communities.

Adaptation planners

- Take an 'ecosystem' approach to adaptation planning
- Identification and implementation of 'win-win' adaptation options across resource sectors such as re-forestation of watersheds
- Incorporate fisheries issues within National Adaptation Programmes of Action (NAPAs) for the Least Developed Countries (LDCs)