CLIMATE CHANGE: IMPLICATONS ON AQUATIC RESOURCES, FOOD SECURITY AND LIVELIHOODS.

Badmus, O. Federal College of Animal Health and Production Technology, Vom, Plateau State Nigeria. lanre2ola@yahoo.com

Obadiah, F.V., University of Agriculture Abeokuta, Ogun State, Nigeria

Yacim, S.E., Federal College of Animal Health and Production Technology, Vom, Plateau State Nigeria.

Laniyi, A.L., Federal College of Animal Health and Production Technology, Vom, Plateau State Nigeria.

Adedeji, F.A., Crescent University Abeokuta, Ogun State, Nigeria.

Abstract

Climate changes are growing environmental concerns which are much in the scientific government and public eye at present. The potential impact on aquatic resources and livelihood are immense. From local to global levels, fisheries and aquaculture play important roles for food supply, food security and income generation. Some 43.5 million people work directly in the sector, with the great majority in developing countries. Adding those who work in associated processing, marketing, distribution and supply industries, and the sector supports nearly 200 million livelihoods. Aquatic foods have high nutritional quality, contributing 20 percent or more of average per capita animal protein intake for more than 1.5 billion people, mostly from developing countries. They are also the most widely traded foodstuffs and are essential components of export earnings for many poorer countries. Extreme events will also impact on infrastructure, ranging from landing and farming sites to post-harvest facilities and transport routes. They will also affect safety at sea and settlements, with communities living in low-lying areas at particular risk. Livelihood diversification is an established means of risk transfer and reduction in the face of shocks, but reduced options for diversification will negatively affect livelihood outcomes.

Key words: Climate change, aquatic resources and food security

INTRODUCTION

The scientific evidence is now overwhelming that climate change has increasing becoming a reality. Scientific studies indicate that the emissions from economic activity, particularly the accumulated of carbon dioxide emitted from burning of fossils fuel from energy, are causing changes to the Earth surface temperature [1].While climate change is already being experience across the globe, it is expected to have a disproportionate effect on those living in poverty in developing countries are in tropics and sub- tropical regions, area predicted to be seriously affected by the impact of climate change: Africa, Asia, Latin America and small island (Mauritius) have all been identified as regions of concern.

By 2020, up to 250 million people in Africa could be exposed to greater risk of water stress that could lead to food insecurity. Sea level will rise as a result of climate change, this could lead to inundation of coast worldwide with some island states possibly facing complete inundation and people living with the constant threat of tropical cyclones now face increased severity and possibly increase frequency of the events with all associated risks to life and livelihoods .The UNFCCC secretariat has estimated that by 2030 developing countries will require USD 28-67 billion in funds to enable adaptation to climate change [1].This corresponds to 0.2-0.8 percent of global investment flows, or just 0.06-0.21 percent of projected global GDP, in 2030.
Africa is already feeling the hard realities of climate change with extensive droughts having terrible impacts on nomadic agriculture and temperature rise contributing to sea level and food security is threatened. Africa's population contributes marginally to the production of greenhouse gases and yet it is being impacted far more harshly than the developed countries that as yet have barely checked their prolific release. As Africa includes some of the world's poorest nations, its resilience to combat weather-related disasters and climatic uncertainty is far from strong.
Africa is such an enormous landmass, stretching from about 350c N to 350c, the climate effect are different to location within the continent. Some areas are drier, others wetter, and some regions may derive economic benefit, while most are adversely affected. Climate change is projected to have far reaching effects broadly across aquatic resources, economies, increasing pressure on livelihoods and food supplies in Africa.

Africa is already a continent under pressure from climate stresses and is highly vulnerable to the impacts of climate change. Many areas in Africa are recognized as having climates that are

among the most variable in the world on seasonal and decadal time scales. Floods and droughts can occur in the same area within months of each other. These events can lead to famine and widespread disruption of socio-economic well-being. For example, estimates reported at the workshop indicate that one third of African people already live in drought- prone areas and 220 million are exposed to drought each year. Many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent's ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. The overexploitation of water resources, increases in population, desertification and land degradation pose additional threats [2] Developed countries have so far committed to cutting emissions by, on average, 15 per cent by 2020. This could lead to global average temperature rises of 4˚C or higher above pre-industrial levels by 2060. Without strategies in place for adapting to a change of this magnitude, Africa will be seriously affected – particularly its agricultural sector. This will in turn have serious implications for the continent's food production and livelihoods. Economic growth and development could be disrupted, ultimately giving rise to severe social and environmental problems.

The United Nations Environment Programme-sponsored Adapt Cost project has recently investigated the economic costs of climate change adaptation in Africa, and will report on these in the run-up to the Conference of the Parties 15 in December 2009. Its researchers modeled the economic costs of a scenario where carbon dioxide or equivalent levels are at 450 parts per million (ppm). This reduces the economic costs of climate change in Africa from 1.5-3 per cent of GDP by 2030 to around 1 per cent of GDP by 2030. It also makes more likely average temperature rises will be limited instead of exceeding 4°C or more.
The agricultural sector is critically important to Africa, both in terms of social and economic development. Over 60 per cent of Africans depend directly on agriculture for their livelihoods [3]. Production ranges from small-scale subsistence farming to large-scale export industries. Agriculture contributes to about 50 per cent of Africa's total export value and approximately 21 per cent of its total Gross Domestic Product (GDP) [4].

Agricultural activity is highly sensitive to climate change, largely because it depends on biodiversity and ecosystems. Sufficient freshwater supplies, fertile soil, the right balance of predators and pollinators, air temperature and average weather conditions all contribute to continuing agricultural productivity. Human interventions, such as excessive extraction of natural resources, forest clearance for pasture or cropland, large-scale mono cropping and use of chemical fertilizers and pesticides, have resulted in biodiversity losses. These can ultimately damage an ecosystem's capacity to adapt naturally to changes in the climate [5].This paper review current knowledge about the relationships between climate change, aquatic resources, food security and livelihoods.

IMPACT ON AQUATIC RESOURCES

Aquatic foods provide 20% or more of average per capita animal protein intake for more than 1.5 billion people, the majority of whom live in developing countries. Climate change impacts, such as warming of oceans, rivers and lakes and changes in precipitation, water salinity and ocean acidity as well as the increases in extreme weather events, will increase the uncertainties in the

supply of fish from capture fisheries and aquaculture. Climate change impacts on natural systems can have profound effects on socioeconomic systems [6]. One example cited by [7] reported that coral bleaching event in the Indian Ocean. This event was unprecedented in severity; mortality rates reached as high as 90% in many shallow reefs, such as in the Maldives and the Seychelles. Such severe impacts are expected to have long-term socioeconomic consequences as a result of changed fish species mix and decreased fish stocks and negative effects on tourism as a result of degraded reefs. Degradation of reefs also will lead to diminished natural protection of coastal infrastructure against high waves and storm surges on low-lying atolls. [8] estimate the costs of the 1998 bleaching event to be between US$706 million (optimistic) and US$8,190 million (pessimistic) over the next 20 years. The Maldives and the Seychelles are identified as particularly affected, because of their heavy reliance on tourism and fishery.

Impact on Coral Reef

Climate change is also clearly impacting on coral reef systems. Mass coral bleaching and resulting mortalities due to increasing temperatures are already reducing the density and diversity of coral reef fishes and other organisms [8]. It is becoming increasingly clear that coral reefs are among those environments most threatened by this phenomenon. An increase in sea surface temperatures, rising sea levels, and more frequent and severe storms are some of the effects of climate change that can negatively impact coral reefs. These negative impacts lead to declines in biodiversity, coastal protection and income from reef fisheries and tourism. The resulting economic loss can total billions of dollars. Recent coral reef bleaching events around the world have re-ignited the debate about the impacts of climate change on coral reefs [9] [7]. According to [10], approximately 27% of the world's coral reefs have been effectively lost; with over half\ of that loss being due to the massive climate-related coral bleaching event of 1998.A study by [9] investigates the economic losses caused by reef destruction in the Philippines. Here coral reef fisheries are worth around US$1billion per year, providing a living to around one million small scale fishers. [10] annualized the pessimistic scenario, bleaching in the Indian Ocean is assumed to lead to a decline in reef services of 50 per cent, starting from year 5, with a lineal growth from 0 per cent to 50 per cent in the first 5 years. In the pessimistic scenario, total damages over a 20-year time period are valued at over US$8 billion, and arise primarily from coastal erosion (US$2.2 billion), tourism loss (US$3.3 billion), and fishery loss (US$1.4 billion). In the optimistic scenario described above, the losses are still considerable, but are of the order of magnitude less than the damage in the pessimistic scenario, and stem mainly from a US$0.5 billion loss of tourism revenue.

Modeling Studies of Climate Change on Aquatic Resources

Considerable progress in estimating the potential impacts of climate change on aquatic ecosystems, in particular with respect to modeling has been reported. Several approaches are now in use in order to forecast the effects of climate change on aquatic resources [11]. These include global static models, global dynamic models, dynamic downscaling approaches and statistical downscaling approaches.[11] noted that statistical time-series analyses can describe previous patterns of variability but may be less useful for forward projections.[12] have made significant quantitative advances on projecting the impacts of climate change on distributions of fish populations, commercial fish and invertebrate biodiversity, and fisheries catch potential using a statistical bioclimatic envelope approach (based on the ranges of temperature and other

physical conditions within which species occur combined with trophic energetic and allometric scaling of metabolism[12]. Models of climate change impacts on aquatic ecosystems have had variable results; with some projecting slight decreases in global average production (e.g. [13]) and others slight increases e.g. 0·7–8·1%; [14], although with large spatial variability.

CLIMATE CHANGE AND FOOD SECURITY

Food production is of course a direct correlate of agricultural productivity. There have been substantial increases in agricultural productivity in recent years [15]. From an average of 100 around 1990, the index of agricultural productivity increased to 186.8 in Benin, to 167 in Ghana, to 156 in Nigeria, to 142.9 in Burkina Faso and to 142 in Guinea in 1999. In these same countries, increases in per capita agricultural output were equally robust.

Agriculture, on which we all depend for our food is under threat from climate change. There is no doubt that systems worldwide will have to adapt, but while consumers may barely notice in developed countries, millions of people in developing countries face a very real and direct threat to their food security and livelihoods. The food price crisis of 2008 has led to the re-emergenceof debates about global food security [16] and its impact on prospects for achieving the first Millennium Development Goal (MDG): to end poverty and hunger. On top of a number of shorter-term triggers leading to volatile food prices, the longer-term negative impacts of climate change need to be taken very seriously.

Agriculture constitutes the backbone of most African economies. It is the largest contributor to GDP; the biggest source of foreign exchange, accounting for about 40% of the continent's foreign currency earnings; and the main generator of savings and tax revenues. In addition, about two-thirds of manufacturing value-added is based on agricultural raw materials. Agriculture remains crucial for pro-poor economic growth in most African countries, as rural areas support 70-80% of the total population. More than in any other sector, improvements in agricultural performance have the potential to increase rural incomes and purchasing power for large numbers of people to lift them out of poverty [17] [16].

World Bank, Commodity Price Data reported tough prices on international markets for food and energy raw materials came down quickly from their mid-2008 peaks, they rose again in 2010-11 and they remain high by historical standards. More than that, the trend in food prices has been noticeably upward over the past decade, in contrast to its downward trend over most of the 20th century; and, since the introduction of biofuel subsidies and mandates particularly in the US and EU a few years ago, food prices seem to be closely tracking fossil fuel prices – again in contrast to most of the second half of the 20th century. (Fig.1).

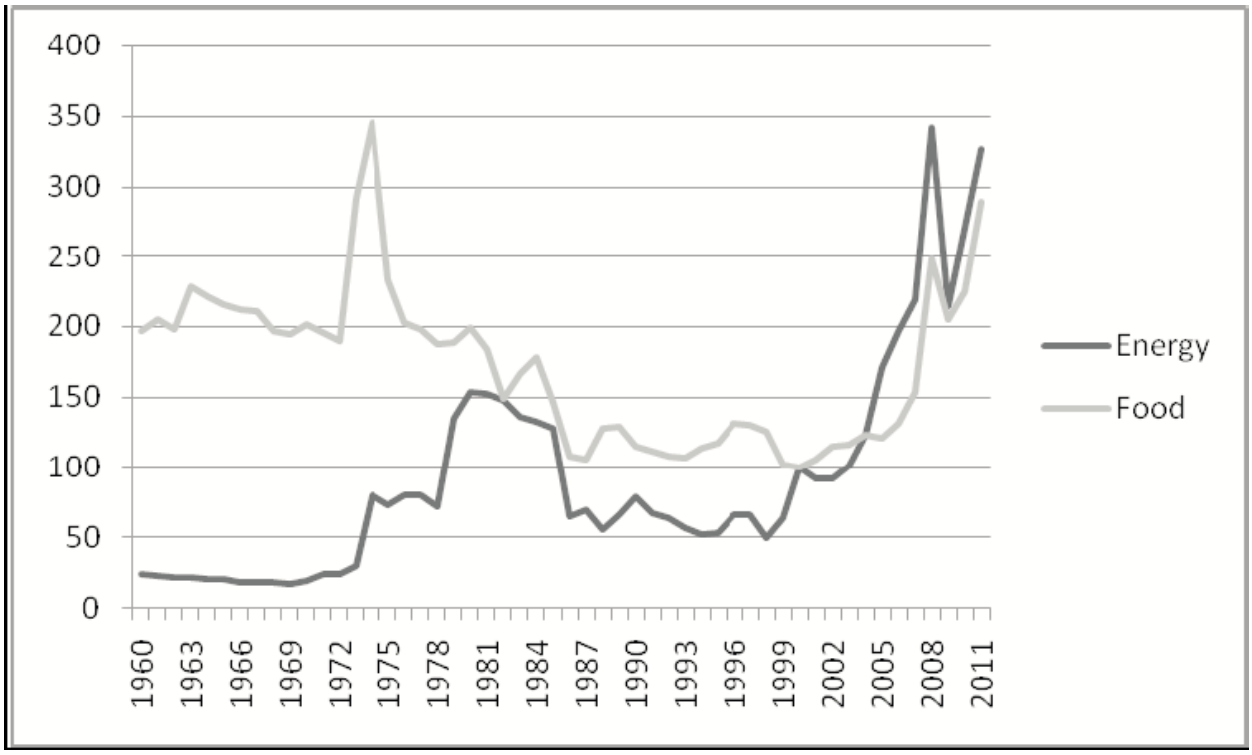

Fig 1.**International price indexes for food and fossil fuel energy raw materials, 1960 to 2011a**

The 2011 data refer only to the first 2 months (January and February). Source: World Bank, Commodity Price Data (Pink Sheets, see [19] http://go.worldbank.org/5AT3JHWYU0).

LIVELIHOODS DIVRSIFICATION AS A RISK MANAGEMENT APPROACH.

One way to reduce vulnerability of poor households is to support them in managing risks by assisting them to diversify their livelihood strategies. As well as supporting diversification within agriculture, it may also involve creation of opportunities for diversification to income sources outside agriculture, such as handicraft production and sale or work as trades' people. Strategies for livelihood diversification must be planned based on the traditional and indigenous knowledge of the communities involved, capturing the full range of hazards people are exposed to, how these hazards interact with each other, and how they affect existing and planned livelihood activities. There are two potential alternative approaches that need to be explored. The first is whether rural livelihoods can be diversified sufficiently to enable adaptation (i.e. within the rural economy) through the diversification of crops and extension to non-farming livelihoods. The second is the need to recognize that in some locations and circumstances, rural agriculture and its livelihoods may become impossible, requiring retreat or abandonment of some areas.

Diversification Strategy

An alternative strategy might be to diversify his livelihood into parallel activities, to keep fishing, but diversify enough to get by, thereby exerting everyday and personal forms of agency. The livelihoods literature is full of evidence of fishers doing just that, particularly to cope during lean periods [19] [20] [21]. As [22] argue, fisher folk diversify their livelihood for very good reasons such as the high risk of the occupation, seasonal fluctuation in the resource, and to reduce the risk of livelihood failure by spreading it across more than one income source. As [23]

illustrate in the context of a small-scale fishery in Cambodia, fishers emphasized that the ability of household members to access multiple types of fishing gear and techniques, or to combine livelihood skills such as raising animals, contributed to the adaptability of the household and successful well-being. However, many fishers who diversify their livelihoods still keep one foot in their fishing boats. This is particularly evident in studies from Indonesia and the Philippines that describe the temporary diversification of fishers into seaweed farming, encouraged as a means of reducing fishing pressure [24]. Many of the fishers involved moved back into fishing, sometimes purchasing new boats with the additional profits from seaweed sales. In many households the seaweed farms were tended by wives and children of fishers, with some women reporting a reduction in household chores and childcare as a result of their involvement [25]. As is documented by [26] (2001:531), through their work on job satisfaction among small-scale fishers in the Philippines, Indonesia, and Vietnam, "most fishers would not leave fishing for an alternative occupation, citing income as well as non income factors for resisting change."

OPTIONS FOR CLIMATE ADAPTATION

There are no definitive ways to tackle climate change across a continent. Solutions must be context specific. Selecting which adaptation options to implement must be based on knowledge of local conditions. Funding for adaptation is not a question of aid: it is an obligation. While the figures remain uncertain, the potential economic costs of climate change for Africa to be 1.5-3 per cent of its GDP by 2030.Africa's potential adaptation financing needs to address these costs are also highly uncertain, but they are likely to constitute a minimum of US$10 billion a year by 2030, and could be £30billion a year, or more.

Adaptation Measures

If adaptation strategies should reflect the dynamics of peoples' livelihoods, then adaptation must be seen as a process that is itself adaptive and flexible to address locally-specific and changing circumstances. The responsibility for adaptation lies with those who stand to gain the most.
While those with the least capacity to adapt are the most vulnerable, they are also the most likely and most motivated to take conscious adaptation actions. For the poor and vulnerable, the actions that they take will be constrained by their limited assets and capabilities, but they will also be the most appropriate given the specific local manifestations of climate change impacts. These actions should be supported by external agencies to build up the asset base of the poor.

Mitigation Options

Human activities such as fossil fuel use and land use/land cover change have resulted in substantial amounts of carbon being added to the atmosphere in the past 200 years. The total annual emissions of carbon to the atmosphere from human activities is about 7.9 Gigatonnes (Gt). About 1.6 Gt (17%) of this is from the land use and land cover change and the rest (6.3 Gt C) from burning fossil fuels. The atmosphere retains about 3.3Gt of this and the rest, by present estimates, is absorbed by the oceans and the terrestrial biosphere in equal quantities [27].
Substantial reduction of the greenhouse gas would be required for the CO2 concentrations in the atmosphere to stabilize during the 21st century to less than twice the pre-industrial level [28] .Mitigation activities permitted under the Kyoto Protocol and Marrakesh Accords can affect wetlands. Under the Kyoto Protocol, there is a provision for the Annex 1 countries (mostly developed countries) to use land use and land use change and forestry activities (afforestation,

reforestation and avoided deforestation and other land-management activities) to meet their emission reduction targets (which overall is approximately 0.1Gt C to the atmosphere annually) [29]. Consistency with national and/or international sustainable development goals could reduce the risk of the negative impacts.

POLICY OPTIONS FOR RESILENCE AND ADAPTATION FOR FISHERIES AND POOR FISHING COMMUNITIES

The policy implications are multidimensional both in terms of strategy and in terms of possible stakeholder engagement. Perhaps the most important policy implication is the need to improve the adaptive capacity of the peasant householder in terms of poverty reduction, higher levels of educational attainment, improved public awareness. There is also the need to develop strategies with the aim of building resilience into the fisheries and poor fishing communities systems and make them less sensitive to climate variability and climate change. Resilience to climate change impacts and an ability to adapt can be assessed in terms of the capacity of people and communities involved in the sector to adapt to climate change. Impacts of climate change may be felt by the catching sector, aquaculture, processors, and traders/marketers in post-harvest activities, or in the wider national economy in countries with high fishery dependence. These suggestions are drawn from earlier reviews of fishing peoples 'existing strategies to adapt to climate variability and change [22] [27] [30] [31]. In this respect, five main lines of activities could be identified. These include:

Stimulating Adaptation Efforts Through Awareness and Scientific Awareness: Although adaptation activity is beginning to take place, further efforts may be stimulated by increasing awareness and education of the potential impacts of climate change. Increasing scientific capacity by improving access to climate data, development of modeling capabilities, and having mechanisms in place to process and disseminate the data for users; helps promote awareness of potential climate change impacts. It also equips communities with climate information necessary for resilience measures, hence increasing their capacity to adapt.

Public Awareness: A communication strategy is an effective way of elaborating and communicating between knowledge providers and stakeholders on climate change risks and adaptation needs, targeting actors ranging from those at the grassroots level to national and regional policymakers, using appropriate language. This communication strategy could include the preparation of a global awareness campaign on climate change, including video messages in different languages.

Cooperation and Synergies: Given that many countries may experience similar effects from climate change, sharing experience can broaden knowledge on how to address the adaptation challenges. Climate change should be integrated into the work of different regional organizations and networks, and in particular though partnerships of sectors such as water and agriculture in order to share experiences and lessons learned by communities facing similar problems. New funding and improved access to funding, is needed to effectively provide technical and financial support and capacity building capabilities. Existing mechanisms on vulnerability assessment and adaptation include forums of ministers, economic commissions, bilateral cooperation initiatives and initiatives to share information and data. Collaboration between Southern institutions helps to share experiences and lessons learned by communities facing similar problems; develop joint

projects; carry out research and development on downscaling of climate scenarios; and conduct workshops and training activities.

Building Capacity to Adapt to Climate Change: Improving social, economic and technical resilience and increasing flexibility within systems is a form of adaptation and allows further adaptation to take place more easily, for example by increasing water storage capacity and extending water supply services. Increasing adaptive capacity may be achieved through sustainable development, supporting the idea that adaptation activities can occur even in the face of uncertainty.
Development plans that incorporate adaptive capacity provide the ability to respond to future uncertainties. Governments and development agencies are beginning to treat adaptation to climate change not as a standalone effort, but rather as an issue to be mainstreamed through all development and environmental policies.

Building on Traditional Coping Mechanisms: Communities that rely on natural resources have been developing methods to cope with environmental change for generations. Tribes in the Turkana region of northwest, Kenya has adopted a nomadic lifestyle to cope with the harsh environmental conditions. However, adapting to predict climate change presents a major challenge. Adaptation should aim to strengthen traditional coping mechanisms: optimizing current systems whilst building flexibility to cope with the uncertainties posed by climate change. Introducing new technology can be sustainable where it strengthens and builds on traditional approaches and reinforces local knowledge.

CONCLUSION

The impacts of climate change will not be felt evenly across the world, and may not all be negative. Some agricultural systems, mainly at higher latitudes and higher altitudes, may benefit at least in the short term from higher temperatures. Some dry areas may get more rainfall. But the most vulnerable – the many millions of people who survive by rainfed agriculture in the dry lands of Africa, the millions more who make up the world's small-scale fishing communities, and those who make their livelihoods in low-lying regions like the Indo-Gangetic Plains, for example – look likely to face some of the most severe impacts, which will probably overwhelm their current coping capacities. Climate change promises serious negative impacts on agricultural systems. These same systems and the aquatic resources that support them are already under severe strain from over-exploitation, the current climate, and multiple other stresses. Many of the world's most vulnerable people depend directly on these systems for their food and livelihoods; and many countries' economies are also highly dependent on them. Such a system would be well positioned to develop resilience and build adaptive capacity in both the natural ecological and human social systems to address the uncertainties of climate change and to sustain the security of aquatic food supplies. We are at a crossroad in the development of our planet. The decisions we make now, for agriculture and aquatic resources as well as livelihoods sustainability, may prove to be the most important decisions humankind ever collectively makes.
Food security is one of the basic human rights that are in jeopardy. Today, an estimated one billion people among 9 billion world population – more than one person in six – do not enjoy that right; without significant changes to mitigate climate change vis a vis agriculture and other natural resource-based systems, hunger and poverty will be perpetuated long into the future, and affect our livelihoods .

REFRENCES

1. Inter governmental Panel on Climate Change. Climate Change 2001: Impacts, Adaptation and Vulnerability, Summary for Policymakers and Technical Summary of the Working Group II Report. Geneva: IPCC, 2001.

2. UNDP. 2006. Human Development Report 2006. Beyond Scarcity: Power, poverty and the global water crisis, United Nations Development Programme. Retrieved from: http://hdr.undp.org/hdr2006/report.cfm

3. FAO Technical guidelines for responsible fisheries No. 10. FAO. 79 pp. Rome. Food and Agriculture Organization, *Responding to Agricultural and Food Insecurity Challenges Mobilizing Africa to Implement NEPAD Programmes,* Conference of Ministers of Agriculture of the African Union, Maputo, Mozambique, July 2003 *Group*, AFDB, March 2008

4 Mendelsohn, R., Dinar, A., Dafelt, A., Climate Change Impacts on African Agriculture, CEEPA, July 12, 2000

5. Ensor, J. *Biodiverse Agriculture for a Changing Climate*, Practical Action, 2009

6. Harvey, N., B. Clouston, and P. Carvalho, (1999): Improving coastal vulnerability assessment methodologies for integrated coastal zone management. Australian Geographical Studie , **37(1)**, 50-69.

7. Wilkinson, C.R., O. Linden, H. Cesar, G. Hodgson, J. Rubens and A.E. Strong. 1999 Ecological and socioeconomic impacts of 1998 coral mortality in the Indian Ocean: An ENSO impact and a warning of future change? Ambio 28(2):196-199.

8. Hoegh-Guldberg, O., Mumby, P. J., Hooten, A. J., Steneck, R. S.,Greenfield P., Gomez, E., Harvell, C. D., Sale, P. F., Edwards, A. J. Caldeira, K. Knowlton, N., Eakin, C. M., Iglesiasprieto, R., Muthiga, N., Bradbury, R. H., Dubi, A. & Hatziolos, M. E. (2007).Coral reefs under rapid climate change and ocean acidification. Science 318, 1737–1742.Retrieved from: http://unfccc.int

9. White *et al* (2000) *Marine Pollution Bulletin, Volume 40, Issue 7, July 2000, Pages 598- 605*

10. Cesar, H. 1996, Economic analysis of Indonesian coral reefs. The World Bank, Washington,D.C.

11. Hollowed, A. B., Barange, M., Ito, S.-I., Kim, S. Loeng, H. (2010). 2010 Symposium on "Effects of climate change on fish and fisheries". pices Press 18, 4–11.

12. Cheung, W.W. L., Close, C., Lam, V., Watson, R. & Pauly, D. (2008). Application of macro ecological theory to predict effects of climate change on global fisheries potential. *Marine Ecology Progress Series* 365, 187–197.

13. Cox, P. M., Betts, R. A., Jones, C. D., Spall, S.A. & Totterdell,I.J. (2000).Acceleration of global warming due to carbon cycle feedbacks in a coupled climate model. Nature 408, 184–187.

14. Sarmiento, J. L., Slater, R., Barber, R., Bopp, L.,Doney, S. C., Hirst, A. C., Kleypas, J., Matear, R.,Mikolajewicz, U., Monfray, P., Soldatov, V.,Spall, S.A. & Stouffer, R. (2004). Response of ocean ecosystems to climate warming. *Global Biogeochemical Cycles* 18, GB3003. doi:10.1029/2003GB002134.

15. FAO (2001); *FAO Bulletin of Statistics;* Vol. 1 pp 1 – 47.'

16. Wiggins S. (2008) 'Rising Food Prices – A global crisis'. Briefing paper No 37. London: ODI.

17. NEPAD (2002) Comprehensive Africa Agriculture Development Programme.

18. Wiggins, S. (2006) *Agricultural growth and poverty reduction: A scoping study*. Working Paper No. 2 on Globalization, Growth and Poverty. Ottawa: IDRC.

19. http://go.worldbank.org/5AT3JHWYU0. World Bank, Commodity Price Data

20. McCay, B. J. 2002. Emergence of institutions for the commons: contexts, situations, and events. Pages 361-402 *in* E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stonich, and U. Weber, editors. *The drama of the commons.* National Academy Press, Washington D.C. USA.

21. Béné, C., A. Neiland, T. Jolley, S. Ovie, O. Sule, B. Ladu, K. Mindjimba, E. Belal F. Tiotsop, M. Baba, L. Dara, A. Zakara, and J. Quensiere. 2003. Inland fisheries, poverty and rural Livelihoods in the Lake Chad Basin. *Journal of Asian and African Studies* 38(1):17-51.

22. Pomeroy, R. S, B. D. Ratnera, S. J. Hall, J. Pimoljinda, and V. Vivekanandan. 2006 Coping with disaster: rehabilitating coastal livelihoods and communities. *Marine Policy* 30(6):786-793. Rettieved from http://dx.doi.org/10.1016/j.marpol.2006.02.003

23. Allison, E. H., and F. Ellis. 2001. The livelihoods approach and management of small-scale Fisheries. *Marine Policy* 25(5):377-388.Retrieved from: http://dx.doi.org/10.1177/002190960303800102

24. Marschke, M. J., and F. Berkes. 2006. Exploring strategies that build livelihood resilience: a case from Cambodia. *Ecology and Society* 11(1): 42. [Online] URL:Retrieved from: http://www.ecologyandsociety.org/vol11/iss1/art42/

25. Sievanen, L., B. Crawford, R. Pollnac, and C. Lowe. 2005. Weeding through assumptions of livelihood approaches in ICM: Seaweed farming in the Philippines and Indonesia. *Ocean Coastal Management* 48:297-313.Retrieved from: http://dx.doi.org/10.1016/j.ocecoaman.2005.04.015

26. Crawford, B. 2002. *Seaweed farming: an alternative livelihood for small-scale fishers?* Working paper for the Coastal Resources Centre, University of Rhode Island, Kingston, Rhode Island, USA. [Online] URL: Retrieved fromhttp://www.crc.uri.edu/download/Alt_Livelihood.pdf

27. Pollnac, R. B., R. Pomeroy, and I. H. T. Harkes. 2001. Fishery policy and job satisfaction in three southeast Asian fisheries. *Ocean and Coastal Management* 44:531-544.Retrieved from: http://dx.doi.org/10.1016/S0964- 5691(01)000643

28. Bolin, B. & Sukumar, R. 2000. Global Perspective. In: *Land Use, Land-Use*

Change and Forestry, RT Watson, IR Noble, B Bolin, NH Ravindranath, DJ Verardo & DJ Dokke (eds.). A Special Report of the IPCC. Cambridge University Press, Cambridge, UK, pp. 23-51.

29. IIPCC. 2001c*: Climate Change 2001: Synthesis Report*. *A Contribution of Working Groups I, II, and III to the Third Assessment Report of Intergovernmental Panel on Climate Change*

30. IPCC. 2000. Summary for Policy Makers. *Land Use, land Use Change and Forestry* Watson, R.T., Noble I.R., Boiln, B., Ravindranath, N.H*., et al.* (eds), pp. 1-20. Cambridge University Press.

.

31. FAO. 2007d. Building adaptive capacity to climate change. Policies to sustain livelihoods and fisheries. New directions in fisheries – a series of policy briefs on development issues, 08. 16 pp.Rome.

32. Daw, Tim, W. Neil Adger, Katrina Brown and Marie-Caroline Badjeck, 2008. in FAO TP 530 in Press