CMFRI

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Impact of Climate Change on Indian Marine Fisheries

Lecture Notes

Part 2

Compiled and Edited by

E. Vivekanandan and J. Jayasankar

Central Marine Fisheries Research Institute (CMFRI),
(*Indian Council of Agricultural Research*)
P.B. No. 1603, Cochin - 682 018, Kerala

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ADAPTATION AND MITIGATION MEASURES

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E. Vivekanandan
Central Marine Fisheries Research Institute, Kochi 682 018
(evivekanandan@hotmail.com)

Introduction

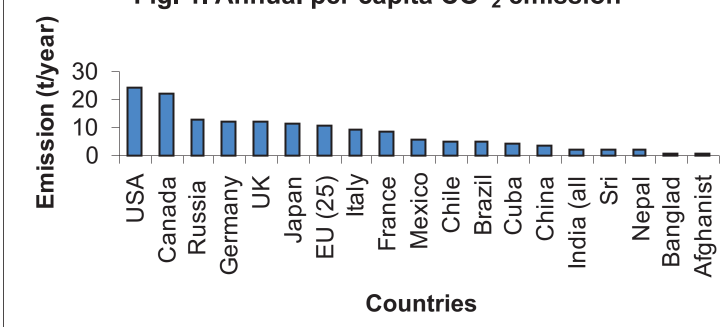
From the observations of increases in global average air and ocean temperature, it is now evident that warming of the climate system is unequivocal. The root cause of global warming is in the increasing concentration of greenhouse gases (GHG), particularly CO_2, in the earth's atmosphere in the period following the industrial revolution. Increases in GHG emissions in the atmosphere are largely because of fossil fuel use, with the energy, transport and industrial sectors accounting for nearly 60% of GHG emissions. The Weather Makers: The History and Future Impact of Climate Change, points out that CO_2 level in the atmosphere in 1800, at the start of industrial revolution, was 280ppm.The most recent level is 380ppm. This indicates that dangerous changes could take place in the climate if CO_2 concentrations exceed double the pre-industrial revolution level by 2100. One of the key debates is the proposal to limit concentrations of greenhouse gases in the atmosphere to between 445 parts per million and 650 parts per million to avoid dangerous climate change, with pressure from developing countries to raise the lower limit. The IPCC IV Report (2007) concludes that stabilization of greenhouse gas concentrations is possible at a reasonable cost, with stabilization between 445ppm and 535ppm costing less than 3% of global GDP.The IPCC estimates that stabilizing atmospheric greenhouse gases at between 445-535ppm CO_2 equivalent would result in a reduction of average annual GDP growth rates of less than 0.12%. stabilizing at 535 to 590ppm would reduce average annual GDP growth rates by 0.1%, while stabilization at 590 to 710ppm would reduce rates by 0.06%.

Climate change could exacerbate tensions and trigger conflicts across the world by worsening food, water, and land resources shortages and increasing the environmental refugees, according to the report "Climate Change as a Security Risk" released by U.N. Environment Programme on Climate Change in Bali in December, 2007. Because climate change might do much harm, controlling it depends on the efforts of governments, scientists, business and industry, agriculture, environmental organizations and individuals. No single person or nation owns the earth's global resources, that is, its oceans and atmosphere. Hence, the people of the world must work together to reduce greenhouse gas emission and warming of the earth.

Global initiatives

Annual per capita CO_2 emission is high in developed, industrial countries (Fig. 1).

Fig. 1. Annual per capita CO_2 emission



All countries will be affected by climate change, but those in the forefront are poor nations, especially small island states and developing economies where hundreds of millions of people live in low-level deltas. It might cause a substantial loss to India's GDP too. Climate change has become central to global development politics. The degree of public pressure, particularly developed country delegations, suggests the beginning of a deeper engagements with the challenges posed by climate change. The proposal put forward by India at the United Nations Framework Convention of Climate Change (UNFCCC) annual meeting at Bali was to take appropriate mitigation actions by developing countries in the context of sustainable development, technology financing and capacity building in a measurable, reportable and verifiable manner.

The main objective of all climate change conferences is to finding out ways in reducing the anthropogenic GHG emissions to tackle rising temperature. Developing countries with booming economies and a growing contribution to climate change must accept flexible and fair commitments to reduce GHG emission.

The important option is to limit the amount of greenhouse gases each nation emits. Under this plan, each country would receive emission "permits" that could be bought and sold. Richer nations with higher emissions per person could purchase permits from poorer nations with lower emissions per person. Thus, the more developed countries would have incentives to create and use more efficient technologies, and less developed countries would receive money that could be used to aid their development.

In 1992, representatives of 178 nations met in Rio de Janeiro for the United Nations (UN) Conference on Environment and Development. This meeting, known as the Earth Summit, was one of the most important global environmental conferences ever held. The UN members signed agreements on the prevention of global warming, the preservation of forests and endangered species, and other issues.

In 1997, more than 150 nations attending a United Nations conference on global warming in Kyoto, Japan, agreed to limit greenhouse gas emissions. The agreement called for 38 industrial nations to reduce emissions of several greenhouse gases, mostly carbon dioxide, to an average of 5 per cent below 1990 levels by the year 2012. In a treaty called the Montreal Protocol, which took effect in 1989, the major CFC-producing nations agreed to gradually stop producing CFC. A 1991 amendment to the treaty called for a total ban on CFCs by the year 2000. By 1996, most industrialized countries had ended production of CFCs.

There are real and affordable ways to deal with climate change. Already, business in many parts of the world are demanding clear public policies on climate change, regardless of what form they might take regulation, emission caps and efficiency guidelines. We need a new ethic by which every human being realizes the importance of the challenge we are facing and starts to take action through changes in life style and attitude.

The mitigation measures suggested for major sectors by the IPCC in the IV Assessment Report 2007 is given in Table 1.

Scientific efforts

Increasing concern over the environment has caused scientists and engineers to look for technological solutions. Some research seeks ways to clean up or manage warming. The goal of other research is to prevent warming. Many industrial researchers are finding more economical ways to use fuels and other raw materials. As a result of their research, some European cities now use waste heat from power plants or garbage incinerators to warm homes. New car engines burn petrol much more cleanly and efficiently than older engines. Researchers have also developed cars that use such clean-burning fuels as methanol (a type of alcohol) and natural gas. In Brazil, some cars use another type of alcohol, called ethanol, as fuel. Scientists are also developing cars that can use hydrogen gas as fuel. Hydrogen creates almost no pollution when it is burned.

Many scientists recommend a reduction in the emissions of greenhouse gases. The least controversial way to reduce such emissions would be to use gains in efficiency to decrease the use of energy. For

Table 1. Key mitigation technologies and practices (source: IPCC IV Report, 2007)

Sector	Key mitigation technologies and practices currently commercially available	Key mitigation technologies and practices projected to be commercialized before 2030
Energy Supply	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CCS (e.g. storage of removed CO_2 from natural gas)	Carbon Capture and Storage (CCS) for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and waves energy, concentrating solar, and solar PV.
Transport	More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning	Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries
Buildings	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycle of fluorinated gases	Integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar PV integrated in buildings
Industry	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies	Advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture

Agriculture	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertilizer application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency	Improvements of crop yields
Forestry	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bio-energy to replace fossil fuel use	Tree species improvement to increase biomass productivity and carbon sequestration. Improved remote sensing technologies for analysis of vegetation/ soil carbon sequestration potential and mapping land use change
Waste	Landfill methane recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimization	Biocovers and biofilters to optimize CH_4 oxidation

example, manufacturers would adopt more efficient processes to produce goods. Makers of electrical equipment would introduce more efficient motors, light bulbs, and other devices. New manufacturing equipment and the new devices might be more costly than those they replaced. However, the savings resulting from decreased energy consumption might help to make up for the extra costs. As a result, the new technologies could reduce emissions and save money.

Scientists and engineers are also researching ways to generate electricity more cheaply from renewable energy sources such as the wind and sun, causing little or no emission. Large fields of windmills, known as wind farms, already supply electricity in several countries. Devices called photovoltaic cells convert sunlight directly into electricity. Using such cells, a photovoltaic power plant in Sacramento, California, U.S.A., produces enough electricity for 1,000 homes.

Experts have also offered a number of more controversial strategies. For example, governments could create regulations that specify the type of technologies used or the amount of fossil fuels burned. Many policy analysts recommend that governments consider a tax on emissions of greenhouse gases.

Carbon credits

The Clean Development Mechanism (CDM) allows developing countries to set up projects in a wide range of sectors such as energy production and distribution, manufacturing and industries, transport, mining and waste disposal that would reduce emissions against a business-as- usual scenario and there by earn "Carbon Credits". One carbon credit refers to one tonne of CO_2 emission avoided by the adoption of a certain practice when compared with a business-as-usual scenario and can be sold on the carbon market to a company in the developed world looking to offset excess emissions. According to Kyoto Protocol 1997, all countries are required to reduce their GHG emissions by 5% from 1990 to 2012 or pay a price to those that do. That is if a country is a consumer of an environmental value like clean air, it must pay a producer of an equivalent value. For example, a biomass gasification project registered with the CDM board in December 2007 in Coimbatore District in Tamilnadu uses coconut husks to produce electricity that is exported to the TNEB. The project claims that the combustion of biomass does not result in a net increase of GHG emissions, and that there are increased efficiencies of between 22 and 37% compared with the conventional biomass combustion technologies. Thus the project claims to produce only 28 tonnes of CO_2 a year as opposed to 3,418 tonnes a year and so earns itself 3,390 tonnes of avoided emissions in the first year. This can be sold as carbon credits and used to finance the project.

About four years ago Good News India reported that Powerguda, a village in Andhra Pradesh, sold carbon to World Bank for $645. The village was selling 147 tonnes of saved CO_2 credits. Powerguda's claim of having saved 147 t of CO_2 is based on the bio-diesel they extracted from 4500 Pongamia trees in their village. Using this bio-diesel instead of petroleum in oil engines would enhance air quality. The World Bank was buying those carbon credits to balance the aviation fuel burnt by aircraft carrying bank officials. This market opportunity created awareness to Andhra Pradesh villages, which enabled carbon credit sales by five more villages. Carbon credits could be implemented in such a manner that ceiling on emissions are imposed for each sector and a failure to meet them would attract penalities. This will help the carbon credit market as a regulated market. Similarly a system could be evolved for imposing a tax on CO_2 emissions. The money obtained through the tax on CO_2 emissions could be utilized for suitable mitigation and adaptation procedures.

According to Reduction of Emissions from Deforestation and Degraded land in Developing countries (REDD) under CDM, deforestation accounts for nearly 20% of global GHG emissions. Curbing deforestation shall reduce emissions and so should be eligible for carbon credits and trade. Conservation of forests can also be included under this scheme.

Carbon credits in the oceans

Plankton and trees both capture CO_2 through photosynthesis and store the carbon in their tissues. This sequestration of carbon helps reduce global warming. At sea, Planktos, for-profit ecorestoration company based in San Francisco uses a process called iron replenishment to restore declining plankton growth in the open seas. They revive plankton populations by adding iron dust to the ocean. Iron is a critical micronutrient needed by plankton for photosynthesis. It normally reaches the oceans in wind-borne iron-rich dust from arid lands, but that dust supply has fallen 30% over the past 30 years, resulting in a 10% decline in plankton populations since the late 1970s. Extensive research projects have shown that adding tiny amounts of iron can powerfully regenerate plankton growth. Stimulating plankton blooms not only captures global warming CO_2, but also restores ocean ecosystems, as plankton is the base of the food chain. Thus, through iron-stimulated plankton blooms in the oceans, they are able to generate carbon credits. They sell these offsets to individuals and businesses that are looking to reduce their carbon footprint and lower their impact on climate change.

Individual efforts

People in upper economic strata emit more CO2. Per capita CO2 emission of a person earning a monthly salary of Rs 30,000 is three times more than a person earning Rs 3,000 (Fig. 2). But the poor bear the brunt of climate change. Their dwellings get submerged; and they cannot afford to own air-conditioners. From an overall perspective, to create the necessary carbon space for the poor, countries must evolve policies and measures to reduce the carbon emissions of the upper people. Among domestic uses, maximum emission is from electricity (Table 2). People can save electricity by buying more efficient light bulbs and home appliances. For example, compact fluorescent light bulbs use only 25 per cent as much electricity as traditional incandescent bulbs. People can also conserve by using appliances less often, by turning off appliances and lights when not in use, and by setting home thermostats at or below 20°C in winter and at or above 26°C in summer. Buildings with specially treated windows and good insulation need far less electricity to heat or cool than buildings witho ut such materials.

Fig. 2. Per capita annual CO2 emission

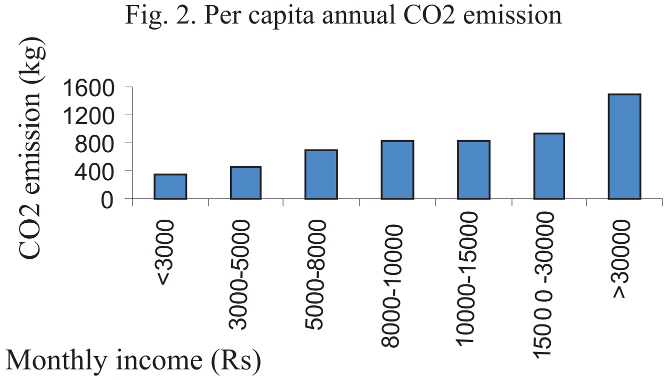


Table 2. Per capita annual CO_2 emission (kg) by different income groups

Per capita CO_2 emission per annum (kg)	Use			
	Total	Electricity	Cooking	Transport
<3000	335	198	97	40
3000-5000	465	279	130	56
5000-8000	685	445	137	103
8000-10000	819	549	137	133
10000-15000	827	521	133	173
15000-30000	936	646	131	159
>30000	1494	1091	120	283
Average	501	326	105	70

Source: Greenpeace India

Using inefficient lighting is responsible for 126 million tonnes of CO_2 emissions a year (7% of India's overall emissions) and it could be cut by as much 95 million tonnes by making compact fluorescent lamps, tube lights and other efficient lighting systems accessible to the poor by price reduction. With a gradual decarbonisation of the energy sector, the use of electricity in households will automatically imply lower emissions.

We can adopt the following approaches: (i) double the fuel efficiency of cars that are expected to be on the roads; (ii) reducing the distance traveled annually per car by half (by traveling in public transport such as train, one can reduce CO2 emission; Table 3); (iii) raising efficiency of heating, cooling, lighting and appliances by 25%; (iv) improving coal-based power plant efficiency from 40% to 60%; (v) carbon capture and storage for large coal-based power plants; (vi) capturing coal-derived hydrogen to power cars; (vii) replacing large coal-based power plants with natural gas; (viii) raising nuclear power production capacity by three times from the present, wind power to 25 times of the present, solar power to 700 times current capacity; (ix) stopping all deforestation; (x) increasing ethanol biofuel production to 50 times the present level; and (xi) expanding conservation tillage to reduce carbon release from agriculture.These technologies can possibly bring down emissions by 50% by 2057 (source: 'Stabilization Wedges' by Princeton researchers).

Table 3. CO_2 emission by various energy uses

Category	CO_2 emitted per unit (kg)
Electricity (per kw)	0.87
LPG (per kg)	2.78
CNG (per kg)	2.67
Coal (per kg)	2.06
Kerosene (per litre)	2.41
Diesel (per litre)	2.46
Petrol (per litre)	2.14
Air (per person/km)	0.26
Train-diesel (per person/km)	0.13
Train-electric (per person/km)	0.17
Firewood (per kg)	1.07
Gobar (per kg)	1.07
Gobar gas (per kg)	2.67

Source: Greenpeace India

Even if global emission stabilizes and if the temperature increase is kept below 2^{o}C, because of the delayed response of ocean warming, the impact of the already warmed atmosphere and surface is inevitable. Hence, along with the strategies of mitigation to reduce greenhouse gas emissions, measures of adaptation to the effects need to be implemented to secure the lives of vulnerable populations, especially along the coastlines.

Marine fisheries sector

The source of GHG emission in the marine fisheries sector is from fishing by mechanized and motorized boats and processing plants. However, compared to several other sectors, GHG emission by fisheries sector is meager. Nevertheless, there is scope for reducing the emission by increasing the fuel efficiency of fishing boats.

For the fisheries sector, the following theme plan to adapt to and mitigate climate change is suggested:

- Impact assessment of climate change on distribution and species diversity of fisheries resources;
- Assessment on production and economic value of commercially important fish in the changed scenario;

- Identify adaptive fishing and post-harvest practices to sustain production and quality;
- Evaluate sensitive biological processes such as growth, maturity and spawning and the adaptive capacity of important fish groups with reference to climate change;
- Identify genes for thermal tolerance;
- Identify new land use system for aquaculture;
- Identify new candidate species and develop breeding and grow-out techniques;
- Assess the changes in feed requirements for changed aquaculture practices;
- Investigations on potential fish diseases in the natural and farming systems;
- Investigations on diversity and dynamics of microbes in the waterbodies;
- Assess demand-supply scenarios for fisheries in the changing scenario;
- Develop regional contingency plans for weather-related risks to the fishing communities;
- Quantify GHG emissions from fisheries sector;
- Quantify the carbon sequestration potential of freshwater, brackishwater and marine ecosystems;
- Identify cost-effective opportunities for reducing GHG emission from fisheries sector;
- Establish Weather Watch Groups for fisheries sector;
- Evolve decision support systems;
- Develop a compendium on indigenous traditional knowledge in the fisheries sector and explore opportunities for its utilization;
- Intensify efforts to increase climate literacy among the stakeholders in fisheries sector.

Climate change response is very complex to deal with. What is required is a non-carbon path, which is so challenging that existing economic tools will not be able to handle. The threat of climate change and the rising oil prices should push governments to reduce their dependence on oil and must seek new alternatives. The consuming class has to change necessarily its life style to consume less. Real change that can effectively prevent major collision with the environment can come about only when the societal order is changed. Civil society needs to create awareness among people and prepare them for change. The most important way people can fight against global warming/climate change is to learn as much as possible about how their actions affect the environment. If people are prepared and aware, change will come dramatically. If handled correctly, the fight against global warming/climate change could set the stage for an eco-friendly transformation of the global economy - one that spurs growth and development rather than crimps it, as many national leaders fear.

Suggested reading

IPCC Report IV, 2007. www.ipcc.org

www.planktos.com