Research Paper

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Evidence Based Climate Change Impacts in India

Engineering

KEYWORDS : climate change, impacts, hydrologic cycle, flood, drought, policy.

Surendra Kumar Yadav Associate Professor (Environmental Sciences), SCR Institute of Engineering & Technology (SCRIET), CCS University, Meerut (UP)-250004, INDIA

ABSTRACT

India is one of the most vulnerable countries to climate change that is affecting agricultural production. India is growing rapidly and represented 8% of the increase in global energy-related CO_2 emissions between 2000 and 2010; analysis suggests that mitigation opportunities with net negative costs can reduce emissions by about 6Gt (gigaton) of CO_2 equivalent/year in 2030. Climate change increased in many hundred deaths due to heat stress in recent years in India. Frequency of hot days and multiple-day heat waves has increased in past century. Warmer climate, precipitation decline and droughts in most delta regions of India have resulted in drying up of wetlands and severe degradation of ecosystems. Drought in many States also resulted in scarcity of ground water and people do not have safe drinking water because climate change has already affected the hydrologic cycle. The key human health impacts of climate change include increases in the incidence of vector-borne disease (malaria), water-borne diseases (diarrhea), heat- and cold-related deaths, and injuries and deaths from flooding and in the prevalence of malnutrition (as agriculture production has reduced). More than 100 people have lost their home/ houses due to rise in sea level at Sundarbans region (largest mangrove area) in West Bengal. Climate change policy has to be effective and require immediate implementation with proper technology applications and instruments.

INTRODUCTION

Climate change is gradual [1], designing for limited or no change in climate conditions while waiting for better information might save money today but will likely result in high future costs for maintenance or earlier replacement of assets if climate conditions are worse than anticipated. Climate is the most important determinant of vegetation patterns globally and has significant influence on the distribution, structure and ecology of forests. Certain climatic regimes are associated with particular plant communities or functional types [2-5].

Changes in climate would alter the configuration of forest ecosystems [6-7]. Recent modeling studies indicate that forest ecosystems could be seriously impacted by future climate change. Even with global warming of 1-2°C, much less than the most recent projections of warming during this century [9], most ecosystems and landscapes will be impacted through changes in species composition, productivity and biodiversity [10]; and these have implications for the livelihoods of people who depend on forest resources for their livelihoods [11]. Temperature increases of more than 2°C will substantially increase the likelihood of irreversible and potentially catastrophic impacts such as the extinction of half of all species (this shall have adverse impact on ecosystem health), inundation of 30 percent of coastal wetlands, and massive increases in malnutrition and diarrheal and cardio-respiratory diseases [12].

Glaciers are considered among the most sensitive indicators of climate change [13], advancing when climate cools and retreating when climate warms. As soil temperature increase, the decomposition rate of organic matter will increase, and then nutrient mineralization and availability for plants uptake become increased at presence of sufficient water if other conditions are unchanged [14]. Climate Change is a serious global environmental concern [15-20]. It is primarily caused by the building up of Green House Gases (GHGs) in the atmosphere [21]. Global Warming is a specific example of the broader term "Climate Change" and refers to the observed increase in the average temperature of the air near earth's surface and oceans in recent decades [22-26].

The clean development mechanism [CDM] allows developing countries to generate Kyoto permits that can be traded in an international market for projects that otherwise would not have been undertaken and which reduce emissions below a baseline [27-29]. The biggest climate impact has been on changing weather patterns in South Asia [30-32]. Over the last 50 years, rising temperatures have led to a nearly 10 percent reduction in the duration and rainfall levels of the annual monsoons that are vital to nearly all Indian agriculture [33]. Various international environmental treaties and laws binding on world community were framed and international responses [34-35] are adopted by Government of India also.

IMPACT ASSESSMENT AND SITUATION

Climate change is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, Changes in groundwater may actually be much greater than the precipitation changes. For example, in places where annual rainfall may increase by 20 percent as a result of climate change, the groundwater might increase as much as 40 percent. Conversely, the analysis showed in some cases just a 20 percent decrease in rainfall could lead to a 70 percent decrease in the recharging of local aquifers, but the exact effects depend on a complex mix of factors. Mountains receive more rainfall than low lying areas because the temperature on top of mountains is lower than the temperature at sea level. That is why you often see snow on the top of mountains all year round. The higher the place is above sea level the colder it will be. This happens because as altitude increases, air becomes thinner and is less able to absorb and retain heat.

Warming directly affects rate of plant respiration, photosynthesis, and other biogeochemical processes. For instance, enhanced CO_2 concentration can increase photosynthetic rate especially for plants growing under warm and dry condition such as C_3 plants. Naturally, plants have their own mechanism to tolerate a certain level of increased temperature. The interaction and different combination effect of rise CO_2 concentration and temperature is determined by soil properties, water, mineral and nutrient availability etc, as a result the expected response of plants in different environments and climate variability can be either positively or negatively affected.

There is need for integrating climate change in development policies and strategies. The entire Himalayan Hindu Kush ice mass has decreased in the last two decades and

the ratio of melt accelerates, consequently, water supply in areas fed by Hindu Kush Himalayan glacier melt, on which hundreds of millions of people in China and India depend, have negatively affected. Serious and recurrent floods in Northeast states of India during 2002, 2003 and 2004 were noticed. A record 944 mm of rainfall in Mumbai during 26-27 July 2005 led to loss of over 1000 lives with loss of more than US$250 millions; floods in Surat, Barmer and in Srinagar during summer monsoon season of 2006 were noticed. Sea-level rise leads to intrusion of saline water into the fresh groundwater in coastal aquifers and thus adversely affected groundwater resources. For two small and flat coral islands at the coast of India, the thickness of freshwater lens was computed to decrease from 25 m to 10 m and from 36 m to 28 m, respectively, for a sea level rise of only 0.1 m.

At Ganges-Brahmaputra delta (also Bangladesh), more than 1 million people will be directly affected by 2050 from risk through coastal erosion and land loss, primarily as a result of the decreased sediment delivery by the rivers, but also through the accentuated rates of sea-level rise. The gross per capita water availability in India will decline from ~1820 m3/yr in 2001 to as low as ~1140m3/yr in 2050. Indian Council of Agricultural Research using crop simulation models indicated that climate change is projected to reduce timely sown irrigated wheat production by about 6% by 2020. In the case of late sown wheat, the projected levels are alarmingly high, to the extent of 18%. Similarly, a 4% fall in the yield of irrigated rice crop and a 6% fall in rainfed rice are foreseen by 2020 due to climate changes. The warming trend in India over the past 100 years is estimated at 0.60°C. Indian Gross Domestic Product (GDP) shows a strong link with the year to year variations of Indian summer monsoon rainfall. The cost between 2010 and 2050 of adapting to an approximately 2°C warmer world by 2050 is in the range of $75 billion to $100 billion a year.

VULNERABILITY AND ADAPTATION

A 2°C warmer world will experience more intense rainfall and more frequent and more intense droughts, floods, heat waves, and other extreme weather events. Households, communities, and planners need to put in place initiatives that reduce the vulnerability of natural and human systems against actual and expected climate change effects. Vulnerability to climate change coupled with other environmental issues has a strong linkage with poverty and responsible to create multiple stresses on the growth of the nation. The Government is implementing the National Action Plan on Climate Change (NAPCC) with a view to enhance the ecological sustainability of India's development path and address Climate Change. The Government regularly reviews the progress under the National Action Plan on Climate Change (NAPCC), based on the information provided by the concerned nodal Ministry.

India has aggressive renewable energy targets and industry energy efficiency policies, but faces significant infrastructure challenges, which may derail otherwise good policy. Some researchers predicted that after few decade there shall be a scenario of 4 ºC rise in global temperature, would result in increased climate extreme events such as heat waves, sea level rise, more storm surges, droughts and flooding in the South Asian region including India. The coastal and deltaic regions of India are reported to be particularly vulnerable to the risks of flooding.

Low carbon initiatives are recommended to achieve sustainable development. Adaptation measures can be classified by the initiating economic sector public or private. There is need for planned adaptation (adaptation that results from a deliberate public policy decision) but not autonomous or spontaneous adaptation (adaptation by households and communities acting on their own without public interventions but within an existing public policy framework).

Important examples of adaptations are; (a) reducing vulnerability (degree of susceptibility of a system to a certain damage) to climate change impacts, focusing on coping strategies and practices to become beneficial by using opportunities associated to climate change by reducing susceptibility and external forces to develop the ability of resilience (increasing tackling capacity of the community and sectors to reduce risk and damages); (b) have effective conservation strategies to maintain natural distribution of biodiversity and ecosystem services, and conserve species and genetic diversity; (c) Improving productivity in terms of quality and quantity is vital to satisfy human needs, through adjusting different growth factors and solving effects of extreme events and associated problems, e.g. preventing spread of pathogens, weeds, dispersion of insect and pests etc; (d) minimize impacts of climate change (its cause and effects) moving forward in researching to identify the responses of plant species to different variable climate conditions, and identifying uncertainty in climate and try to avoid challenges in practicing adaptation; (e) finally, increased environmental benefits from forest ecosystems by afforestation and reforestation to reduce degradation and loss of habitats.

ACTION PLAN

The negative impacts of climate change will be experienced most intensely by the poorest people in developing countries. Social variables further interact with institutional arrangements that are crucial in promoting adaptive capacity, including those that increase access to information, voice, and civic representation in setting priorities in climate policy and action. A three-step methodology has been developed to help planners integrate climate risk and resilience into development policies and planning. The first is to identify and validate climate-resilient investment alternatives using a multi-criteria decision analysis. This involves qualitative and quantitative impact assessments for each sector, consultation at the national level (government, policymakers, technical experts), and participatory workshops with community representatives and local authorities at the county level. The second step is to conduct a cost-benefit analysis for identified climate-resilient investment alternatives at a specific geographic unit. The final step is to implement an investment planning model that allows the government to prioritize and sequence robust adaptation strategies into development plans and budgets.

Adaptation requires understanding the potential impacts of climate change on human, economic, and ecological systems. The Intergovernmental Panel on Climate Change (IPCC) has developed six socioeconomic scenarios that characterize possible trajectories of emissions. A scenario is a coherent, internally consistent, plausible description of a possible future state of the world. According to the IPCC, however, all scenarios have more or less the same projected temperature increase up to 2050 (a timeframe arguably more relevant for adaptation), even though there are large uncertainties regarding carbon dioxide emissions within each scenario. Therefore, the selection of scenarios for this study depends largely on the availability of global climate model data.

Developmental activities versus climate change are an im-

portant aspect for NAPCC. Action on Climate Change must enhance, not diminish the prospects for development. It must not sharpen the division of the world between an affluent North and an impoverished South, and justify this with a green label. What we require is a collaborative spirit which acknowledges the pervasive threat of Climate Change to humanity and seeks to find answers that enhance, not diminish the prospects of development, particularly of developing countries.

There is substantial economic potential for mitigating global GHG emissions (by offsetting the projected growth of global emissions or reducing them below current levels) over the coming decades. Realizing this, of course, requires dealing with implementation barriers. The economic mitigation potential, which is generally greater than the market mitigation potential, can only be achieved when adequate policies are in place and barriers removed. Drawing on both primary and secondary data, this paper analyzes the material and ideational drivers that are most strongly influencing policy choices at different levels, from international negotiations down to individual states.

The goal is to encourage long term investment decisions to move towards less carbon intensive activities. This approach could be unilaterally implemented in India. If successful it would not only reduce Indian carbon emissions but it would be an example for the entire developing world to follow and it might remove a key obstacle preventing the United States from implementing policies based on the argument that developing countries are not committed to taking action to reduce greenhouse emission. The development of institutions to manage risk as well as the clear commitment to taking effective action against future carbon emissions has the potential to be an attractive option for a country like India. If it was shown to be successful in both stimulating foreign investment in energy development and reducing the trend of greenhouse emissions through market based incentives based on the clear establishment of property rights, the demonstration effect across the developing world would be powerful.

The NAPCC must address properly the issue of power generation, renewable energy and energy efficiency. Future energy infrastructure investment decisions, expected to total over 20 trillion dollars between 2005 and 2030, will have long-term impact on GHG emissions because of the long lifetimes of energy plants and other infrastructure capital stock. The widespread diffusion of low-carbon technologies may take many decades, even if early investments are made attractive. Initial estimates show that returning global energy-related CO_2 emissions to 2005 levels by 2030 would require a large shift in the pattern of investment. Two basic measures are necessary to reduce impacts of climate change; (1) practicing mitigation (reducing causes of climate change) by reducing emission of greenhouse gases (GHGs) from the source, by substitution and conservation of energy, improving carbon sequestration, etc and (2) practicing potential adaptation measures, (e.g. reducing the impacts of climate change). All countries, developing and developed, need to adapt to climate change because ecosystems are inter-connected. Even with government interventions, societies and ecosystems will not be able to adapt to impacts of this magnitude.

CONCLUSIONS

India has covers by coastal zones (three side) are home to an ever growing concentration of people and economic activity, yet they are also subject to a number of climate risks, including sea-level rise and possible increased intensity of tropical storms and cyclones. These factors make adaptation to climate change critical. Coastal adaptation costs are significant and vary with the magnitude of sea-level rise, making it essential for policymakers to plan while accounting for the uncertainty. Water supply and flood management ranks as one of the top three adaptation costs in both the wetter and drier scenarios.

Climate change affects agriculture by altering yields and changing areas where crops can be grown. Changes in temperature and precipitation from both climate scenarios will significantly hurt crop yields and production with irrigated and rain-fed wheat and irrigated rice the hardest hit. Health problems like malaria and diarrhea shall rise due to climate change. The important objective must include protecting the poor through an inclusive and sustainable development strategy, sensitive to climate change and achieving national growth and poverty alleviation objectives while ensuring ecological sustainability.

As a climate change co-benefit, a large-scale conversion to biomass-energy can decrease India's greenhouse gas emissions. the climate change related objectives were to remove barriers and reduce implementation costs for productive and household use of biomass-based renewable energy in support of sustainable rural development, reduce greenhouse gas emissions by substituting fossil-fuel–based energy and traditional greenhouse gas-intensive biomass energy with modern renewable energy technologies. a conceptual framework for understanding the diverse forms of impacts in an integrated manner is proposed, and future research needs are identified. There are three ways to deal with this uncertainty (i) wait for better information, (ii) prepare for the worst, and (iii) insure. There is need to build better models and ultimately reduce the uncertainty in our projections of future monsoon rainfall.

ACKNOWLEDGEMENT

Author wish to thank Hon'ble Vice Chancellor, Ch. Charan Singh University, Meerut (UP), India, for his constant support and encouragement during this research work.

REFERENCES

[1] Kirschbaum, M. U. F., Cannell, M. G. R., Cruz, R. V. O., Galinski, W. and Cramer, W. P. (1996), "Climate change impacts on forests. In: Climate change 1995, Impacts, Adaptation and Mitigation of climate change: Scientific-Technical Analyses", Cambridge University Press.

[2] Fisher-Vanden K.A et al (1997), "Carbon Taxes and India", Energy Economics 19 (3): 289-325.

[3] Holdridge, L. R. (1947), "Determination of world plant formations from simple climatic data", Science, 105: 367-368.

[4] Thornthwaite, C. W. (1948), "An approach toward a rational classification of climate", Geographical Review, 38: 55-94.

[5] Walter, H. (1958), "Vegetation systems of the earth and ecological systems of the geo-biosphere", Springer-Verlag, Berlin.

[6] Whittaker, R. H. (1975), "Communities and Ecosystems", Macmillan, New York.

[7] IPCC. (1996), "Climate Change : Impacts, Adaptations and Mitigation of Climate Change", Scientific-Technical Analyses, Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK.

[8] Solomon, A. M. (1986), "Transient responses of forests to CO2-induced climate change: simulating modeling experiments in eastern North America", Oecologia, 68: 567-579.

[9] IPCC. (2001), "Climate Change : Synthesis Report", 2001a, Intergovernmental Panel on Climate Change, Geneva, Switzerland.

[10] IPCC. (2001), "Climate Change: The Scientific Basis, Summary for Policy Makers and Technical Summary of the Working Group I Report", 2001b, Intergovernmental Panel on Climate Change, Geneva, Switzerland.

[11] Leemans, R. and Eickhout, B. (2004), "Another reason for concern: regional and global impacts on ecosystems for different levels of climate change.

Global Environmental Change", 14: 219-228.

[12] Gitay, H., Suarez, A., Watson, R. T. and Dokken, D. J. (2002), "Climate Change and Biodiversity", Intergovernmental Panel on Climate Change.

[13] World Bank. (2010), "World Development Report : Development and Climate Change", Washington, DC: World Bank.

[14] Seiz, G.; N. Foppa (2007), "The activities of the World Glacier Monitoring Service (WGMS)". (Report).

[15] Yadav S K (2007), "Soil Ecology: Remote Sensing & GIS in Management", APH Publishers.

[16] Energy Information Agency (2004), "International Energy Outlook", Department of Energy, Washington DC.

[17] Fisher-Vanden K.A et al (1997), "Carbon Taxes and India", Energy Economics 19 (3): 289-325.

[18] Gupta S. and S. Hall (1997), "Economic Growth, Energy Demand and Carbon Dioxide Emissions in India: 1990-2000", Environment and Development Economics 2(2): 173-193.

[19] Hertel T. (2001), "Global Trade Analysis: Modeling and Applications", Cambridge University Press Intergovernmental Panel on Climate Change, Climate Change, 3 vols., Cambridge: Cambridge University Press.

[20] Jorgenson, Dale W. and Peter J. Wilcoxen (1991), "Global Change, Energy Prices and U.S. Economic Growth," Structural Change and Economic Dynamics, 3(1): 135-154.

[21] Kemfert, Claudia (2001), "Economic Effects of Alternative Climate Policy Strategies," FEEM Working paper 85.01 (also mimeo University of Oldenburg).

[22] Kumar K, S. Kavi and J. Parikh (2001), "Indian Agriculture and Climate Sensitivity", Global Environmental Change, 11: 147-154.

[23] Löschel, A. and Z.X. Zhang (2002), "The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech," Weltwirtschaftliches Archiv – Review of World Economics, 138(4).

[24] McKibbin W. D. Pearce and A. Stegman (2004), "Long Run Projections for Climate Change Scenarios" forthcoming working paper The Lowy Institute for International Policy and ANU.

[25] McKibbin, Warwick J. and Peter J. Wilcoxen (1997), "A Better Way to Slow Global Climate Change," Brookings Policy Brief, no. 17, June, Washington: The Brookings Institution.

[26] McKibbin, Warwick J. and Peter J. Wilcoxen (2002), "Climate Change Policy After Kyoto: A Blueprint for a Realistic Approach", Washington: The Brookings Institution.

[27] Murthy N S, Panda M and Parikh J. (1997), "Economic Growth, Energy Demand and Carbon dioxide Emissions in India: 1990-2020", Environment and Development Economics 19: 327-354.

[28] Pachauri R. (2003), "Global Climate Change: Indian Perspective Revisited and Restated".

[29] Parikh J. and K Parikh (2002), "Climate Change: India's Perceptions, Positions, Policies and Possiblities", OECD seminar paper , OECD Paris, 30 pages.

[30] Pizer, William A. (1997), "Prices vs. Quantities Revisited: The Case of Climate Change," Resources for the Future Discussion Paper 98-02, Washington: Resources for the Future.

[31] Shukla P. D. Chosh and A. Garg (2003), "Economic Drivers of Greenhouse Gas Emissions in India Future Energy Trends and GHG Emissions for India".

[32] Shyamal P., Bhattacharay R. (2004), "CO2 Emission from Energy Use in India: A Decomposition Analysis", Energy Policy, 32 (5): 585-593.

[33] Toman M., U Chakravorty and S. Gupta (2003), "India and Global Climate Change : Perspectives on Economics and Policy from a Developing Country", Oxford University Press, 366 page.

[34] Weyant, John (1999), "The Costs of the Kyoto Protocol: A Multi-model Evaluation," The Energy Journal, Special Issue.

[35] Ministry of Environment (2015), "Forests and Climate Change", Government of India, Report (1999-2015).