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DATA REQUIREMENTS AND STATISTICAL CHALLENGES FOR DESIGNING CLIMATE FRIENDLY ENERGY POLICIES IN MULTILATERAL FRAMEWORK

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Abstract

India needs reliable good quality database and methodologies for designing, implementing and monitoring climate-friendly policies. This paper focuses on the database needs for policies in the context of multilateral frameworks. It provides suggestions to the Central Statistical Organization (CSO for improving the adequacy and quality of environmental statistics relating to climate change in India for designing climate-friendly policies, assessing economic, social and environmental impacts of mitigation and adaptation programmes, and articulating India's concerns and trade-offs in different multilateral forums.

Key Words: *Climate Change; Indian Agriculture; Environmental Valuation; Spatial Econometrics; Adaptation*

JEL Codes: *Q54, Q1, R1*

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1. INTRODUCTION

Understanding the causes and consequences of climate change, and design of mitigation and adaptation strategies to deal with global warming require knowledge in physical sciences, natural sciences and social sciences . Different disciplines in these sciences use different approaches for collecting /generating data, development of indicators, and analysis of data. For some purposes, researchers use a combination of census, sample survey and remote sensing data. Some of the datasets are generated as by- products of routine administrative or /and regulatory requirements. Very often the databases are imperfect in terms of coverage and lack of correspondence between theoretical constructs and empirically observable magnitudes, and are also subject to unknown margins of errors.

The Fourth Assessment Synthesis Report of the Intergovernmental Panel on Climate Change recognizes different treatments of uncertainty in these disciplines and states how qualitative uncertainty, quantitative uncertainty and uncertainty in specific outcomes are assessed in the report [IPCC (2007)]. Environmental statisticians must report the sources of data, the coverage, the methods used for collecting data, the nature and extent of errors of different types, and when there is uncertainty indicate plausible range of values rather than the arithmetic means.

Our understanding of physical linkages between the atmospheric concentration of greenhouse gases (GHGs) and its temporal and spatial impacts on different ecosystems is imperfect. Valuation of consequences of the accumulation of GHGs on different ecosystems and on human wellbeing is a daunting exercise because some of the outputs/outcomes are either non-marketed or non-marketable, and even when some of them are marketed the market prices may not reveal the social costs/benefits because of the externalities, imperfections in the markets

and distortions in the market prices. As the basket of services consist of private goods, merit goods, public goods and some goods with intrinsic values, different valuation methods are needed for the different goods. A few researchers would even question the use of cost benefit analysis for valuation of intrinsic/ incommensurable values.

Climate change is global in its causes and consequences. GHG emission is a global public bad and GHG reduction is a global public good. Unlike public goods such as national security, law and order, and macroeconomic stability where decisions about optimal levels of supply are decided largely by governments, the aggregate supply of this global public good, i.e. GHG mitigation, depends on the decisions and actions of millions of consumers, producers, government agencies and other non-state actors all over the world. Many mitigation/ adaptation strategies yield a basket of benefits – some local, some regional and the rest global. Hence, policies are needed at global, national and local levels to internalize the environmental externalities in decision making at all levels. As GHG mitigation by any one country yields benefits to all other countries, international cooperation is necessary to avoid the free rider problem.

Another way of looking at the climate change problem is to view the climate system as a global common. Principle 7 of the Rio Declaration states that 'States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental problems States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressure their societies place on the global environment and of the technologies and financial resources they command'. This principle recognizes that protection of global commons is a "common heritage of mankind" [United Nations Conference on Environment and Development

(1992)]. A diluted version of this principle now used is "common concern of humankind".

The above considerations suggest that India's climate change policy is set in regard to both international protocols /policies and national policies based on conscious assessment of our national goals , priorities and policy trade –offs. The dictum "think globally and act locally" is appropriate in this context. Environmental statistics on climate change must provide the data base and methodologies for designing and assessing India's climate-friendly environmental policies. We need in-depth studies on the measurement of the social costs and social benefits of contemplated policies for the weighing of trade-offs among alternative courses of action and to make rational choices among measures and instruments of adaptation and mitigation.

This paper looks at India's data needs and challenges in designing climate–friendly environmental policies in multilateral contexts while safeguarding our interests. Section 2 deals with salient features of the relevant multilateral forums, focusing on the opportunities and challenges for India' policy makers. It also covers India's National Action Plan on Climate Change (NAPCC). Section 3 deals with conceptual issues relating to definition of environmental goods in the context of fast-track liberalization of trade in climate-friendly environmental goods and the lack of consistent and comparable database for assessing the national impact of alternative courses of action. Section 4 deals with issues relating to access to and technology transfer in the context of UNFCC. It also addresses the regulatory issue of determining the procurement prices for wind energy and biomass energy in the context of clean development mechanism (CDM). In these sections we identify the data gaps/inadequacies and suggest what needs to be done to enhance the quality of information and analysis for policy prescriptions. Section 5 contains concluding remarks.

2. MULTILATERAL FRAMEWORKS FOR CLIMATE CHANGE POLICIES

The United Nations Framework Convention on Climate Change (UNFCCC) is the multilateral framework for integrated efforts to tackle the problem of climate change. This Convention entered into force on 21 March 1994. 192 countries ratified the Convention. Article 3.1 states that the Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof. Article 3.3 mentions precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. It notes that, where there are severe threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures.

Article 4 says that the Parties have a right to, and should promote sustainable development. It states that the developed country Parties shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1.They also shall provide such financial resources, including those for the transfer of technology, needed by the developing country Parties to meet agreed full incremental costs of implementing the measures.

The Global Environmental Facility (GEF) is a financial mechanism of the UNFCC for allocating and disbursing funds to developing countries for projects in climate change with global benefits. Climate change mitigation projects cover reducing or avoiding GHG emissions in the areas of renewable energy, energy efficiency, and sustainable transport. Climate change adaptation projects aim at increasing resilience to the adverse

impacts of climate change of vulnerable countries, sectors, and communities. The financial assistance is based on the incremental cost approach. There are five steps in the incremental cost analysis.

The steps are:

Step 1: Analysis of Business as Usual Scenario: What would happen without GEF?

Step 2: Analysis of global environmental benefit with GEF: Identification of domestic and global, and global benefits.

Step 3: Estimation of the incremental cost of the global benefits and agreement on the nature and magnitude of the global benefits.

Step 4: Determination of result based logical framework stating, vision and goals, assumptions, risks and expected outcomes.

Step 5: Co-financing giving source, type and extent of co-finance, and outcome based budget table. See Global Environmental Facility (2007) for further details.

The challenges are: (1) Computation *of economic* costs; (2) Identification and measurement of (i) domestic benefits, (ii) domestic and global benefits, and (iii) global benefits; and (3) Measurement of incremental cost of global benefits. The measurement of incremental cost of global benefit is simple only when the project "without GEF" and the project "with GEF" differ only in global benefits. When there are joint and common costs we may need combinatorial accounting for cost allocation.

The clean development mechanism (CDM), defined in Article 21 of the Kyoto Protocol, allows a country with an emission-reduction under the Kyoto Protocol to implement an emission reduction project in developing countries. Such projects can earn marketable certified emission reduction (CER) credits, each equivalent to one tonne of carbon dioxide which can be counted toward meeting the Kyoto targets. CDM has become operational since the beginning of 2006. More than 1000 projects have been registered and are anticipated to produce CERs

amounting to more than 2.7 billion tons of carbon dioxide equivalent in the first implementation period of Kyoto Protocol of 2008-2012.

A CDM project proposal should establish the following additionalities in order to qualify for consideration as a CDM project activity: (a) The project should lead to real, measurable and long term GHG mitigation ;(b) The funding for CDM project should not lead to diversion of official development assistance; (c) The project activity should lead to transfer of environmentally safe and sound technologies and know-how; (d) The project must also assist in achieving sustainable development. The steps involved in a CDM project are: project identification, government endorsement, establishing the addionalities, validation, registration, monitoring and issue of CERs. See Government of India [Ministry of Environment and Forests (2008)] for further details.

The principle of sustainable development has been accepted by the UNFCC and many other multilateral environmental agreements, the World Trade Organization and many national governments. This principle requires that environmental sustainability assessments of all policies must consider economic, social and environmental effects.

India's National Action Plan on Climate Change (NAPCC) recognizes that climate change is a global challenge and India will engage in multilateral negotiations in a positive, constructive and forward looking manner. It identifies measures that promote our development objectives while also yielding *co-benefits* for addressing climate change effectively. It notes that the 'success of our national efforts would be significantly enhanced provided the developed countries affirm their responsibility for accumulated GHG emissions and their full commitments under the UNFCC, to transfer new and additional financial resources and climate friendly technologies to support both adaptation and mitigation in developing countries' [Government of India (Prime Minister's Council on Climate Change) (2008)].

The NAPCC hinges on the development and use of new technologies. The eight national missions are: National Solar Mission, National Mission for Increased Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture and National Mission for Strategic Knowledge for Climate Change. The Technical Document spells out the technological options available, co-benefits, R&D collaboration, technology transfer, policy and regulatory options and capacity building needs.

3. FAST TRACK TRADE LIBERALIZATION IN CLIMATE – FRIENDLY ENVIRONMENTAL GOODS

The Doha Ministerial Declaration [WTO (2001)] aims at maintaining the process of reforms and liberalization of trade policies, thus ensuring that the system plays its full part in promoting recovery, growth and development. It seeks to place the needs and interests at the heart of the Work Programme. Paragraph 31 of the Work Programme on trade and environment is on enhancing the mutual supportiveness of trade and environment. Para 31(iii) deals with the 'reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services'.

Two factors have slowed down agreement on the product coverage. The first is lack of universally accepted definition/classification of environmental goods (EGs).The second is the difficulty in carrying out national impact assessments of the proposed trade liberalization because of the absence of direct links between the international trade statistics based on HS six digit codes and industrial production statistics based on ISIC at three digit/ four digit levels. The difficulty is compounded by the

fact that even the six digit level HS trade statistics is inadequate for identifying single use EGs.

Definitions/Classifications of Environmental Goods (EGs)

Three classifications are suggested. (a)The OECD definition classifies environmental sector as the set of 'firms producing goods and services capable of measuring, preventing, limiting or correcting environmental damage such as pollution of water, air, soil as well as waste and noise-related problems. This includes cleaner technologies, products and services that reduce environmental risks and minimize pollution and resource use'. Based on this definition, the OECD categorized environmental management functions, and defined a corresponding list of 164 goods providing these functions.

(b) The APEC list was compiled in the late 1990s based on the proposals from the individual APEC members as a bottom up approach to early voluntary sectoral liberalization initiative which included environmental sector, but there was no consensus on the definition and categorization of environmental industry. To advance voluntary liberalization of environmental goods by its Member States, in 1998 APEC assembled and published a list of environmental goods. The APEC list is based on identifying products that are needed for a set of environmental functions similar to those used by the OECD and has 54 goods in common with the OECD list.

(c) The UNCTAD classified environmental goods mainly in terms as environmentally preferable products (EPP). EPPs are classified into three broad groups, according to their environmental justification or benefit. They are (a) products that are more environment-friendly than similar products (at some stage of their life cycle). Examples of these are jute and biomass fuels. (b) Products which are produced in an environment-friendly way (production/processing stage). These include organic coffee, cocoa and tea or tropical timber from sustainably managed forests.

(c) Products that contribute to the preservation of the environment e.g., products which enhance the value of tropical forests such as non-timber forest products; rattan and bamboo are examples. The same products may fall into one or two categories of EPPs. For instance, jute is more environment-friendly than polyethylene, but it can also be grown organically. UNCTAD provides the following criteria for identification of EPPs. They are based on: (a) use of natural resources and energy, (b) amount of waste generated along the life cycle, (c) impact on human and animal health, and sustainable development) preservation of the environment.

The HS System

The Harmonized Commodity Description and Coding System (HS) developed by the World Customs Organization (WCO) is the legal instrument that forms the basis for customs tariffs and the international statistical system. At the WTO, countries have HS numbers for products up to the six digit level. Beyond that, as product descriptions get more specific, different members use different codes and descriptions This HS has 21 sections, 96 chapters, 1244 headings and 5224 subheadings. As of March 2006 more than 200 countries and economic/customs unions, together accounting for almost 98 percent of world trade were using the HS.

There is no specific section for EGs. One option available is to amend the HS classification system, but it is difficult in the short run. The main obstacle to amending the HS in advance of concluding an initiative on EGs is the timing of the Organization's review cycles. The WCO's Council generally considers amendments in four-year cycles, with implementation taking place from 1 to 2 years after they have been notified to Members. The most recently completed review was approved by the WCO Council in June 1999 and implemented internationally on 1 January 2002. For the current review cycle, administrations were requested to submit to the WCO Secretariat their proposals, particularly

any comprehensive proposals, for changes by no later than the end of June 2003. Completion of the review cycle according to schedule requires that all proposed amendments to the HS be finalized by the April 2004 Session of the Review Sub-Committee and its implementation will enter into force on 1 January 2007, which means that any new amendments not included in the current set will not be implemented before 2012. In short, any amendment of the HS before concluding an agreement on environmental goods is unlikely.

The problems with the OECD and APEC lists are: (i) the number of items is large, (ii) some items have no direct environmental use, and (iii) many items have multiple uses, environmental and non-environmental. Many developing countries are not ready for fast track reduction of tariff and non-tariff barriers on such large-scale because (a) most of them are net importers of the EGs, (b) in view of the relative low tariff levels for the EGs in developed countries and relatively high tariffs in developing countries, the trade liberalization will result greater market access largely to developed countries, (c) there will be considerable loss in customs revenues to developing countries, (d) there may be adverse effects on domestic EGs in developing countries, and (e) the very objective of the Doha Development Round of facilitating increased participation of developing countries will not be achieved unless their export potential is increased via transfer of environmentally sound technologies on favourable terms and technical assistance and capacity building are achieved simultaneously.

The World Bank report (2007) explores the opportunities for win-win-win solution via liberalizing trade in environmental goods and services under Doha Round Negotiations Paragraph 31(iii). It identifies 43 goods in the list of 153 environmental goods submitted for discussion in the WTO (JOB (07)54) as climate- friendly. The choice of goods was based on their importance for the environment and customs workability. It also notes that, at six-digit HS code level, clean energy technologies

and components are often found /lumped together with other technologies that may not necessarily be classified as environmentally sustainable technologies or clean technologies. An example is that solar photovoltaic panels are categorized as "Other" under the sub classification for light emitting diodes (LEDs) under the HS codes. Such a categorization suggests that reducing the customs tariff on solar panels might also result in tariff reduction for unrelated LEDs. Similarly, technologies relevant for clean coal electricity generation and for cleaner industrial use are not clearly classified under a separate HS category, which makes them difficult to track. In cases where the codes are not detailed enough, the scope of the tariff reduction becomes much broader than necessary. The 43 products are classified into 7 groups as in Table 1.

Table 1: 43 Climate -friendly Products Classified by Groups: Use, RCA, Net Export, Tariff in India

Group	HS codes (Nos.)	Single Use (Nos.)	EG (Nos.)	RCA >1 (Nos.)	Trade balance>0, (Nos.)	Applied tariffs %
Air pollution control	3	1	2	2	1	0, 7.5, 10
Management of solid and HWs and recycling system	6	0	0	3	-	0,5,7.5,10
Renewable energy plant	24	2	7	3	5	0,7.5,10
Heat and energy management	2	0	1	0	0	7.5,10
Waste water management and potable water treatment	3	0	1	0	1	0,7.5,10
Cleaner or more energy efficient technologies and products	3	0	0	0	0	10
Environmental monitoring, analysis and assessment equipment	2	0	0	0	0	0,7.5,10
Total	43	3	11	8	7	

It may be noted that only 3 items come under single use environmental goods. Only in 8, revealed comparative advantage (RCA) is greater than one and only in 7 India's trade balance was positive in 2006-7. For the 43 products in 2007-08 India's exports and imports were US$ 1.604 billion and US$ 2.408 billion respectively. In view of the trade deficits in most of the items, RCAs only in about 20% of the products, small increases in India's exports because of anticipated small absolute reductions in foreign tariffs, likely increases in India's imports and the consequential impacts on emerging domestic environmental goods industries, and as the anticipated environmental benefits are uncertain, cautious trade liberalization is needed [Sindhu, Sankar and Jomit (2008)].

The need for finding a solution using the HS system arises because it is the legal basis for monitoring trade flows and fixation of customs tariffs due to its ease in customs verification and it facilitates cross country comparisons of the trade data. The HS system at the 6 digit level takes into account raw material base, stage of processing and to some extent product characteristics. But the classification is not based on any environmental criteria i.e., natural resource use, energy consumption, emissions, and waste generation per unit of output. Sometime a HS six digit code also lumps together technology, intermediate inputs and finished products and it is difficult to ascertain whether a technology is clean or dirty and whether or not a product is organically produced.

A long term option is amendment to the HS to create separate sections for EGs. What is the criterion for identification of EG? If it is based on clean technology, is the product distinguishable from a similar product? If not, one has to gather data product- wise and technology-wise. Also, clean technology is a relative term, depending on the spectrum of existing technologies and future technologies. A technology assessment of India's baseline scenario and its future potential in the international context, and a road map for technology transfer and

indigenous development is needed. If it is based on environmental harm per unit of output (measured in terms of pollution and natural resource degradation), we need data not only on inputs and outputs but also on natural resource use, influents, and effluents, and production and process methods. Inclusion of such data would make the data collection process cumbersome and time consuming, and the reliability of data may be questionable.

In the short term the following options are available. (i) EGs may be identified as ex-outs beyond 6 digit level by each country, and a mechanism may be developed by the WTO to arrive at a simplified and harmonized list to facilitate custom verification. (ii) Ecolabeling based on international standards may be evolved for selected EGs, along with technical and financial support for developing countries. (iii) Developing countries may develop duty drawback scheme based on certification for environmental use. Each of these options involves transaction costs and is susceptible for misuse.

For assessing the impact of the trade liberalization in terms of output, employment, growth potential, and technology development, it becomes necessary to establish links between trade statistical system and industrial statistical systems. There are two problems: (1) The CPC data have less detail than the HS; none of the classifications is based on any environmental criterion. Two attempts have been made to establish links between production and trade data. (1) Nicitio and Olarreaga (2007) developed trade, production and protection data for 29 manufacturing sectors for 100 countries for the period 1976-2004. They used ISIC Rev 2 data at the three digit level and comTRADE data of the UNSD for this purpose. (2) North American Industry Classification System (NAICS) was developed by Canada, Mexico and USA to analyze the effects of NAFTA. It is supply-oriented and those establishments using the same production process to produce a good or service is grouped together.

4. DEVELOPMENTS OF ENVIRONMENTALLY SOUND TECHNOLOGIES AND TECHNOLOGY TRANSFER

The Preamble to Science and Technology Policy 2003 recognizes the central role of science and technology 'in raising the quality of life of the people of the country, particularly of the disadvantaged sections of society, in creating wealth for all, in making India globally competitive, in utilizing resources in a sustainable manner, in protecting the environment and ensuring national security' [Government of India (Department of Science and Technology) (2003)]. This policy also takes into consideration, among other things, economic, social and environmental objectives.

Technology policy involves choice between borrowing technologies developed abroad and indigenous development of technologies. The choice depends on costs of imported and indigenous technologies, availability of technologies appropriate to our needs and terms of access, barriers to access and dissemination, and long term prospects of indigenous development with spin-off benefits. An assessment of trade-offs among economic, social and environmental goals is necessary before investment decisions on R& D and technology development / import of technologies is made to ensure sustainable development.

Agenda 21 Chapter 34 of UNCED (1992) says that ESTs 'are not just individual technologies, but total systems which include know-how, proceedures, goods and services and equipment as well as organizational and managerial proceedures'. Thus there are four aspects of transfer of ESTs: (a) infoware, including designs and blueprints which constitute the document embodied knowledge on information and technology; (b) technoware, which includes the physical aspects, i.e., machinery and equipment; (c) humanware, which includes skills, human aspects of technology management learning and adaptation; and (d) organware,

which covers production arrangement linkages within which the technology is operated.

This chapter also notes that ESTs should be 'compatible with nationally determined socio-economic, cultural and environmental priorities'. Thus the concept of environmental soundness is relative; it is also an evolving concept changing with developments in technology and environmental standards. Some ESTs developed in the North may not be appropriate to some developing countries in the South because these technologies were developed keeping in view the environmental standards, factor endowments and factors prices prevailing in the North. Even when such ESTs are available, there may be export restrictions or their prices may be high or there may be costs associated with their adaptation. Thus there is a case for indigenous development of ESTs in the South. See Sankar (2008) for further discussion.

The GEF and CDM are two mechanisms for transfer of ESTs to developing countries under the UNFCCC. The GEF funding is limited to the net incremental cost of the global benefits, i.e. reduction in GHGs. The project financing exercise involves identification and measurement of domestic, domestic and global, and global benefits along with their incremental costs. Substitution of conventional fossil fuel based projects (baseline project) by energy efficient projects such as projects based on integrated gasification combined cycle (IGCC) technology or substitution of thermal plant by non-conventional energy sources will yield different bundles of domestic and global benefits. The cost allocation problem is a challenge when some of the costs are joint or common. One has to rely on cooperative game theory to find a unique cost allocation based on Shapley Value, satisfying individual rationality, coalition rationality and Pareto optimality. Even in such a case developing countries receive financial assistance only equal to the incremental cost of the global benefit. An allocation based on cooperative benefit sharing scheme will also give developing country partners a share in the global net benefit.

Even the simple method of separable cost and remaining benefit gives a share in the benefits .This method is:

$$C_i = IC_i + \left(\frac{d_i}{\sum d_{ij}}\right)(C(Q) - \Sigma\, IC_i)$$

where, Ci is cost allocated to activity i, ICi is incremental cost of activity i, di is (SACi – ICi,) and SACi is stand alone cost for activity i, and C(Q) is the total cost. For a discussion of cost allocation methods, see Sankar (1995).

Regarding CDM, as of June 2008, the CDM Authority of India has approved 969 projects including 533 in renewable energy, 303 in energy efficiency and 6 in forestry. 340 of the projects registered to the CDM Executive Board .India accounts for about 32 per cent of the world total .India's projects would generate 493 million certified emission reduction (CER) credits by the year 2012, if the entire host –country approved projects in India go on stream.[Government of India (Prime Minister's Council on Climate Change)(2008)] . Seres (2008) finds that of the 3296 CDM project design documents he analyzed roughly 36% of the projects accounting for 59% of the annual emission reduction claims involved technological transfer. Of the Indian CDM projects, only 16% of the projects with annual emission reductions of 41% involved technological transfer.

There are many problems in the effective utilization of the CDM mechanism. First, most small producers of renewable energy perceive high transaction costs in availing the CDM benefits. We need a facilitation mechanism. Second, most of India's CDM proposals in renewable energy are unilateral and there is no technology transfer. Third, most state electricity regulatory commissions fix the procurement tariffs on the basis of cost plus tariff method which weakens the incentive for renewable energy suppliers to seek CDM credit. As a result domestic consumers pay for the global benefits. Only a few suppliers of renewable energy get

CDM credits and in such cases the state regulatory commissions have prescribed a mechanism for sharing the CDM benefits between the generating units and the distribution licensees.

We also need a drastic change in our electricity tariff policy from the historical average cost pricing to economic costing with prices for different categories reflecting their marginal social costs. Comparison of the private unit cost of electricity from conventional fossil fuel based electricity with the cost of renewable energy is meaningless as the former ignores the environmental cost of energy. We need a holistic approach to energy costing and pricing to internalize all the environmental costs in the production decisions so that we are informed about the social costs of alternative sources of energy and the alternative mitigation options.

Social cost benefit analysis of alternative mitigation strategies such as carbon capture and sequestration in coal –based power plants, switch from conventional thermal plants to the ones based on energy efficient technologies, and energy from renewable sources will not only convey the relative social costs of energy now for planners but will also be useful in arriving at an optimum mix in energy planning and on decisions relating to the technology transfer and indigenous development.

5. CONCLUDING REMARKS

As climate change is global in its causes and effects and as there is both multilateral framework and India's national action plan for both mitigation and adaptation, our statistical system must gear up to meet our capacity building requirements in negotiations and policy formulation.

First, we need a critical assessment of the data base in terms of coverage, adequacy, reliability and suitability in the measurement and monitoring of the causes, pressures, impacts and responses related to

climate change. Second, there is a need to integrate climate change and social and economic development into a common framework, and to develop and implement effectively integrated social, economic and environmental policies on mitigating and adapting to climate change [Cheung (2008)]. Third, conventional method of data gathering such as census, sampling, and reports of administrative/ regulatory agencies must be supplemented by remote sensing data with GIS applications, research reports and perceptions of stakeholders both on mitigation and adaptation strategies. Fourth, developments in new accounting methods should be used to generate data suitable for economic costing, cost allocation and measurement of incremental costs. Fifth, valuation of ecosystem services, specifying the methods used, sources and magnitudes of error/biases, nature and type of uncertainty, is needed. Sixth, our statistical system must provide the knowledgebase and capability for articulating our concerns and trade offs at the UNFCCC and other international conventions.

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