

## **Session 3: How adequately do IAMs reflect the existing socio-economic structure in Developing Countries?**

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## **Economic Structure in Developing Countries**

**P.R. Shukla**

**Socio-Economic Dynamics of Developing Countries:  
Some Ignored Dimensions in Integrated Assessment**

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**Abstract:**

Despite notable progress, the integrated assessment (IA) framework (and models) for climate change have remained ignorant about vital developing country processes. This paper examines IA from a southern perspective, with an aim to identify and rectify the gaps in representing the socio-economic dynamics of developing countries. The genesis of this ignorance is traced to the limited vision of neoclassical, market oriented economic models and a confused notion of development. Some notable features of the socio-economic dynamics of developing countries are presented. The dynamics influencing adaptation to climate change impacts are discussed. The genesis of the controversy on value of life is examined and its resolution is proposed from a southern perspective. An agenda for representing the developing country dynamics in IA is proposed. A robust IA paradigm, with features like disaggregated and hierarchical modelling, procedural and structural transparency and purposive orientation, is also proposed.

**The Integrated Assessment: Fusion of Science and Art**

Integrated assessment (IA) of climate change assimilates the economics of emissions mitigation, atmospheric changes from the emissions, consequent climate changes, change in the sea level, and their impacts, into a single framework. Despite a history of over two decades, the IA remains *relatively immature and lacks a shared body of professional knowledge and standards of "best practice"* (Weyant et. al., 1996). In two decades, the researchers from diverse disciplines covering natural and social sciences were attracted by the multifarious dimensions of the climate change problem. The term IA in this paper is used generically to describe the assessment of climate change, whether it is performed by a formal model or a less rigorous framework. An integrated assessment model (IAM) fuses several disciplinary models into a unified framework. Interdisciplinary teams have developed numerous IAMs (Dowlatabadi, 1994; Weyant et. al. 1996).

Whereas disciplinary research contributed some crucial insights into the specific aspects of the climate change problem, global policy making called for a wider perspective to choose the responses. IA emerged to fulfil this need. Integration offered several advantages such as interfacing science with policy, providing a coherent language for dialogue across disciplines and offering a consistent framework for comparing the efficacy of alternate strategies to mitigate problems. In as much as disciplinary research belongs to the domain of science, integration is more an art of joining together the pieces to make a coherent whole. In so doing, the IA provides the context and the vision to the disciplinary research and also makes it relevant for incorporating feedbacks and assessing the responses.

**Focus and Aim of this Paper**

Unlike a comprehensive review (Weyant et. al, 1996) or a critique (Parson, 1995) of IA, this paper has a limited focus and aim. This paper examines the current integrated assessment models, frameworks and studies from a southern perspective with an aim to identify and rectify the gaps in representing the socio-economic dynamics of developing countries. The approach is

to identify the gaps and suggest means to resolve the gaps, with the intention to enhance the efficacy and credibility of IA. The scope of this paper is limited to socio-economic aspects. Issues pertaining to natural sciences are not examined. The relevance of the theme is evident from the growing importance of IA in climate change policy analysis, and the rapidly rising emissions from developing countries and their high vulnerability to impacts.

## The Genesis of Ignorance

IA is viewed as a framework which merely supplements disciplinary research without replacing or augmenting it (Weyant et. al, 1996). IA borrows its biases from the research frameworks and models developed in different disciplines. Within the unified framework of IA, biases become more apparent as their effect gets multiplied.

- 1) ***Ignorance and biases in disciplinary research:*** The disciplinary research on climate change originated and advanced in the industrialized countries (Shukla, 1995). The perspectives and focus of this research, in the natural as well as social sciences, were shaped by the dynamics and experiences in the industrialized nations. North-South differences were less pronounced in the natural sciences due to the neutrality of natural systems. These grew sharper in social sciences due to the vastly increasing differences in social dynamics across north and south nations. The biases were manifested in myriad ways such as: i) presuming universal existence of efficient and functioning markets, ii) treating economic efficiency as the singular criterion for assessment and the GDP as a sole measure of welfare, iii) equating the socio-economic dynamics of developed and developing countries, iv) little regional or sectoral disaggregation, and v) little procedural transparency in valuation of crucial parameters like the value of life or probability of extreme events. Here, it was more a case of ignorance than bias. IA inherited these biases from the disciplines and is unable to overcome them as it is merely “*meant to supplement disciplinary research but not to replace it*” (Weyant et. al, 1996)."
- 2) ***Selective Response to UNFCCC mandate:*** An important context of IA is Article 3 of the United Nations Framework Convention on Climate Change (UNFCCC) (UNEP\WMO, 1992). IA analysts frequently refer to a statement from the UNFCCC Article 3(3): “*..... policies and measures to deal with climate change should be cost effective so as to ensure global benefits at the lowest possible cost....*”. The cost effectiveness is thus mandated as an important criterion for assessing the strategies for stabilizing atmospheric concentrations of CO<sub>2</sub> and other greenhouse gases (GHGs). A problem with the current IA studies is that they consider world dynamics as identical regardless of the stage of development of nations, and presume cost effectiveness as the sole criteria and GDP its only measure. This perspective ignores other pertinent statements from the same Article 3 of the UNFCCC which asserts that to achieve the stabilization cost effectively “*such policies and measures should take into account different socio-economic contexts....*” (from Article 3(3)); or “*Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change*” (from Article 3(4)). The current IA studies respond to the UNFCCC mandate only selectively. In the process, while counting the tress, they miss the wood.
- 3) ***Failure to broad base the perspective:*** The ignored statements from the UNFCCC have been prophetic. The policy makers made these statements, as if in anticipation, to caution against a narrow or biased assessment. They placed a broader mandate before the research community. The ignorance of development processes have however blinded the IA studies to adequately respond to this mandate.

## Development: A "Chicken and Egg" Enigma

The importance of developing countries in future global climate change strategies is increasingly recognized. A distinction is made to suggest that the developing countries deserve a separate treatment. But little is said about what distinguishes developing countries and developed countries, except for the technological backwardness and market inefficiencies in developing countries. Due to widely prevalent inefficiencies and low exchange value of currencies, the global studies relying on market dynamics and cost effectiveness invariably point to developing countries as the focal points of future emissions mitigation and impact adaptation actions. In reality, the promise has proved illusory in wake of incorrect understanding of the development process.

1) ***The "no regret" paradox:*** A case in point is always made of the numerous low lying "no regret" opportunities in developing countries, which despite obvious "proof" of their existence from a market perspective, have resisted being harvested. This phenomenon has baffled the energy efficiency aficionados for a long time. Often, inefficiencies are seen as the cause of underdevelopment. Their removal is regarded as a singularly important measure leading towards the pathway of development. The paradoxical existence of "no regret" is explained by myriad barriers to efficient market functioning. Some barriers are attributed to socio-political processes. Most others are just anomalies to be overcome. Their removal became a precondition for energy efficiency. The energy efficiency problem thus transcended from engineering into the socio-economic domain. Some energy efficiency experts, with no practical or conceptual understanding of the socio-economic dynamics of the developing countries, ventured into social sciences and developmental processes. Understanding development became a necessary condition for resolution of the "no regret" paradox.

2) ***Caricaturing of Development:*** Apparently, resolution of the paradox needed understanding of development processes. The northern perspective viewed the socio-economic dynamics of developing countries only as a caricature of developed nations. No essential differences were discerned between the two systems. The inefficiencies of the developing world were rationalized only as barriers to markets, such as resulting from weak institutions and infrastructure. Market inefficiency and underdevelopment became synonymous. A plethora of energy efficiency studies, that followed during the last decade, repeated only the hackneyed solutions to remove barriers and make the markets function. As markets were contiguous, the energy experts realized that energy markets alone can not become efficient. The solution to the energy efficiency paradox thus needed efficiently functioning markets in general.

Mystically, the solutions to energy efficiency problem got linked with the resolution of all the ills of underdevelopment such as poverty, illiteracy or even population. Making the market function was the sole remedy for development. The complex developmental processes looked fathomed in a single formula. Developing country dynamics were caricaturized in the image of the developed countries. Since development was seen solely from the market perspective, market efficiency measures emerged as the favorite panacea for all developmental problems, including the "no regret" paradox. The paradox, instead of resolving, transformed into an enigma whether market development shall precede efficiency or whether the removal of inefficiency shall be the precondition to unshackle the economy and open the road to development.

3) ***The "Chicken and Egg" Enigma:*** The quintessence of the proposed solutions to "no regret" paradox was a mere tautological truth that - the solution to underdevelopment is development (of markets). Market efficiency was the sole criterion of development and cost effectiveness its sole measure. The remedy for harvesting the "no regret" opportunities and to remove inefficiencies was to become developed. But at the same time, in a global competitive

system, development can only be a chimera to those who are inefficient. In a manner typical of the “chicken and egg” enigma, the solutions and the problem thus chased each other. By presuming development as a solution, an entire epoch of transition was overlooked. The reality was wished away and the “ideal” became real in the models.

A most primary modelling principle, that good frameworks or models abstract reality pertinently and reality does not emerge from the models, was forgotten. No wonder, “insights” from the models most often proved to be the consequences of modelling oversights. The “no regret” opportunities proved more stubborn than expected and resisted being wished away. Since IA has borrowed knowledge from the disciplines, the same parody is now plaguing the IA. The first time however, it was an excusable ignorance. But now it seems no more justified. As remarked by Hegel, *the first time it happens as a tragedy, then as a farce*. IA has inherited the weak understanding of development from neoclassical economics. Not correcting this will tantamount to perpetuating the error.

### **Socio-economic Dynamics of Developing Countries**

Some notable features, which characterize the socio-economic dynamics of developing countries (Shukla, 1996a), as pertinent to the IA (and IAMs) are presented next. The discussion is limited in the context of IA and is focused only on the gaps in the economic models, such as in the market-based, efficiency oriented, neoclassical equilibrium models which are the underlying economic backbone of IAM structure.

1) ***Dual Economy and Transition Processes:*** The developing economies function in two distinct spheres, modern and traditional. Each has different socio-economic dynamics which are enveloped by transitional processes. The modern sector dynamics are akin to the market based economic systems. Here, production and investment decisions follow the logic of the market. The traditional sector dynamics are very different. Their logic is often extra-economic in the sense that the sustenance of productive activities is not solely determined by economic considerations but by socio-political processes such as traditions and social or political control. The logic of production, consumption, saving, market exchange, level of resources use, type of technologies and institutional structures are different for each. For instance, the production function for a crop produced by a subsistence farmer engaged in traditional agriculture differs vastly from that for the same crop produced under modern agriculture in the same country (Moulik et al., 1990). Unlike modern agriculture, production in traditional agriculture is for subsistence and not for markets. Consumer choices also vary widely across the modern and traditional domains due to variable access to markets, information, infrastructure and traditions. Representation of the traditional sector requires explicit inclusion of non-market activities, localized resources, subsistence behavior, biomass energy, excess labor and technological isolation.

Development, as a transition process, manifests in evolving consumer preferences, frequent shifts in government policies to adjust to political transitions, and different rates and quality of technological developments in the two sectors. A vital gap in present models, in terms of capturing transitional processes, pertains to the representation of land and labor dynamics. Land dynamics manifests in restricted land market and diverse land tenure and land use practices. Labor dynamics manifests through complex processes like rural to urban migration, changing family structure, change in linguistic and cultural identity etc., all of which have profound welfare implications. In developmental transition, the share of informal and traditional sectors in the economy declines over time. The traditional and informal activities get formalized and shift to the modern sphere. Unless this is explicitly recognized, economic growth projections tend to be overestimated in models. The representation of transition processes in the developing countries is often ignored under the plea that since the time horizons of IAMs are

very long, the transitions will precede the impacts of climate phenomena. This is a tenuous proposition. Development has manifested enormous inertia. Economic transitions occur through very slow processes. The impacts of climate change are likely to be felt in the second half of the twenty first century. It is far less likely that developmental transitions in most developing countries shall precede this period.

2) **Informal Activities:** The informal sector exists in all nations but its extent in the developing nations is vast. In 1980, the non-monetary output to GDP (called Monetization Ratio) was: 0.80 for India, 0.93 for Zambia, 0.95 for China and 0.98 for Argentina (Bose, 1993). Developing countries also have a sizable underground economy and a growing urban informal sector. In India, illegal income was estimated to be 50.7 percent of the GDP in 1987 (Gupta, 1992). The pervasiveness of the informal sector in the urban areas of developing nations is evident from employment statistics. Employment in the informal sector in Calcutta was 40 to 50 percent in 1971 and 45 percent in Jakarta in 1976 (Sethuraman, 1981); and 44.6 percent in Bombay in 1961 (Joshi and Joshi, 1976). The informal sector share of the urban labor force in eleven Latin American countries ranges from 30.3 to 57.0 percent (Lubell, 1991) employing 30 million persons in the late 1980s (Tokman, 1989). In Kenya, employment in the urban informal and rural non-farm sector in 1985 was estimated at 30 and 13 percent respectively of all employment outside agriculture (Livingstone, 1991).

In urban areas, informal activities include street trading, unregistered factories and shops, informal housing (Lubell, 1991); and numerous self-employed persons in petty trades including transport, scavenging, casual labor transactions in urban construction trade and domestic service. Besides, there are numerous informal activities in rural areas like artisan work, cattle tending, household work by women including collection of fuel-wood, dung and drinking water (Cecelski, 1991); irrigation water transactions among farmers (Kolavalli and Chicoine, 1989; Shah, 1993); subsistence agriculture and tribal economy in forest areas. The informal sector transactions account for between 30 to 70 percent of countries' GNP and cover most rural markets, and the peripheral but growing urban sector (Jagannathan, 1987).

3) **Informal Financial Markets:** Informal financial markets play a crucial role in developing nations. Informal lending mechanisms provide significant credit to small enterprises and households in Sri Lanka (Sanderatne, 1989). In Cameroon, 70 percent of the adult population participates in informal financial associations, which in 1988 had deposits equivalent to 54 percent of the total savings of Cameroon (Lubell, 1991). Informal credits accounts for about a third to two thirds of total credit in Bangladesh and China; about two-fifths in India and Sri Lanka; and two-thirds to three-quarters in Malaysia, Nepal, Pakistan and Thailand (Montiel et. al., 1993). Exchange restrictions in developing countries have also contributed to the growing illegal market of foreign currencies and goods. Exchange rate premia for developing country currencies are evident, ranging from a few percentage points to over hundred percent of the official market rate. For instance, in Brazil at the end of 1986 the official rate was 14.9 cruzados per dollar while the black (illegal) market rate was 31.5 cruzados per dollar, in Peru the official and black market rates in late 1988 were 700 and 2000 intis per dollar respectively and in India the black market rate in the 1980s was 25 to 35 percent higher than the official rate (Grosse, 1992). On the other hand, the official and black market exchange rate of Colombian peso showed little divergence in 1980s primarily because of the inflow of narcotics dollars from the underground economy (Grosse, 1992).

Informal finance dominates credit submarkets catering to small, poor and risky borrowers and also competes with and complements formal finance in other submarkets (Ghate, 1992). The informal credit market is linked to formal sector finance through the "middle men" who provide the credit in the informal sector often at interest rates as high as five hundred percent per annum (Hemmer and Mannel, 1989). A study of money lending in the informal

credit market in Malawi observed an interest rate as high as five thousand percent per annum (Bolnick, 1992). These observed rates in informal markets are too high to be explained using the concepts of risk and transaction costs alone and points to a need for developing altogether different concepts for understanding and explaining the dynamics of informal sector realities.

4) **Modelling and Policy Implications of Informal Sector:** Informal markets have endogenous logic and serve varied purposes. They integrate the community and provide a safety net (Lowenthal, 1975; Lowenthal, 1981). Exchange rules of traditional and informal economies are often different and deserve separate consideration (Cantor et. al., 1992). In the traditional sector of developing countries, information in the product and factor markets is scarce and the institutional structure is weak. Consequently, the market does not resemble the smoothly operating institution assumed by neoclassical economics. Personalized and informal contracts are resorted to for circumventing the imperfect information (Geertz, 1978) and institutional gaps. High cost of information and weak institutional base offers transactors rent seeking and defrauding opportunities in both production and exchange (Jagannathan, 1987). On the informal market, services are sold at a price lower than the formal market, and the benefit of tax evasion is shared by the transactors (Ours, 1991) and the corrupt administration (Jagannathan, 1987).

The size and extent of the informal and traditional economy's interface with the formal economy is too significant and extensive to be ignored. The existence of the parallel currency market also creates variety of distortions in the economy through increase in supply of goods, impact on domestic prices, inflation rate, currency value, and has implications for welfare (Bhagwati and Larsen, 1973). Besides considering recorded accounts, macroeconomic policies and plans must explicitly take the informal (Bhattacharyya, 1990) and the traditional economy into account, else they will be ineffective. Informal and formal sectors are closely interlinked. The policies should therefore be made by considering the economy in totality rather than for each sector in exclusion (Anheier, 1992).

5) **Land Relations and Land Use:** Land use practices are key determinants of net GHG emissions and impacts of climate change (IPCC (WGIII), 1996). Some notable features of the developing economies are traditional land use, dependence of sizeable population on land for livelihood and significant contribution of agriculture to GDP. The distinguishing features of traditional land relations are: i) nonexistent land market, ii) small and fragmented land holding, iii) land use for subsistence production, and iv) technological isolation. The productivity under traditional land use is highly climate dependent. Also, practices such as shifting cultivation have direct implications for climate change. Barring a few models (Morita et al., 1993), IAMs scantily treat the land relations and land use issues which are central to the socio-economic dynamics of developing countries.

6) **Market Performance and Disequilibrium:** The market-based, efficiency oriented, neoclassical equilibrium models presume the commodity and factor markets to be in equilibrium. The prices and sectoral demands, used for forecasting future trends, are considered as the outcomes of equilibrium conditions. Realities in developing country points to the contrary. Most major markets, even in the modern sector, remain in perpetual disequilibrium. Except for the labor market, which has excess supply, the other markets experience perpetual excess demand. For instance in India, energy markets exhibit persistent excess demand. On April 1, 1996, over thirteen million household consumers were in the waiting list (CMIE, 1996) for getting an authorization for liquid petroleum gas connection. The waiting period to clear the present queue is estimated to exceed a decade and by then several million new aspirants are expected to join the queue. The electricity sector too is in a perpetual disequilibrium. Excess demand manifests in frequent power shut downs during peak hours. The present gap between electric power demand and supply during peak hours is sixteen percent and is increasing (CMIE, 1996). Due to excess demand in energy markets, the increase in energy price leads to a higher



consumption since supply improves. Under these circumstance, elasticity estimations, presuming equilibrium conditions, tend to be misleading. In the traditional sector, due to weak market institutions, major commodities like biomass energy are scarcely transacted through the market.

7) **Traditional Biomass:** Biomass fuels are the primary energy resources for the traditional sector of developing countries. Biomass is the world's fourth largest energy source, provides fourteen percent of the world's energy needs and thirty five percent of energy in the developing nations (Hall, 1991). Biomass is collected primarily by household labor. Combustion efficiency of traditional biomass cookstoves is very low, about eight percent. Although present biomass use is unsustainable and adds to carbon flux, the biomass can be carbon neutral if used sustainably. The importance of biomass to climate change is obvious, for instance from the fact that, globally, fourteen million hectares of deforested land in 1989 contributed a net effect of adding 1.4 giga tons to atmospheric carbon flux (Rosillo-Calle and Hall, 1992).

Biomass, in India, accounts for over a third of energy use and provides the cooking energy needs of most rural households and half of the urban households (Ravindranath and Hall, 1995). Biomass collection engages a sizable population, mainly women. Collection time, about three hours per household daily (Mahadevia and Shukla, 1997), is increasing due to depletion of village woodlots. Biomass does not acquire monetary value as it is collected by unpaid household labor and is not traded. Estimates suggest that the time spent on biomass collection in India is equivalent to eight billion person days, i.e. a full time employment equivalent of thirty million persons or eleven percent of the total employed in India. Implicit value of non-traded biomass energy, at a minimum labor wage, is a hundred and fifty billion rupees or four percent of GDP. Its kerosene equivalence is twenty four million tons, or forty percent of petroleum products consumption in India. The representation of traditional biomass use is thus important for IAMs. Yet traditional biomass and land relations remain overlooked in IAMs. A key future agenda for IA shall be to explicitly represent traditional biomass use in the developing countries.

8) **Policy Distortions:** The commodity prices, especially energy prices, in the developing countries are administered and are not market determined. For instance in India, the prices of refined petroleum fuels vary substantially. The price of kerosene available to households is a eighth of the price of petrol and a third of that of diesel (CMIE, 1996). The average electricity price for agriculture is only a tenth of the price paid by the industries (CMIE, 1996). Many state governments in India vie to provide free electricity and water to farmers. The socio-political compulsions behind such policies are in themselves a fascinating area of study. The present IA perspective and framework fails to recognize the different policy dynamics, diversity of prices across the regions and sectors, and the socio-cultural and political aspects influencing policies.

Many developing countries are at present undergoing market oriented economic reforms. The price and demand estimation which use past trends needs to take into account the major policy shifts. Besides the pricing distortions in developing countries, the government monopoly in the energy and infrastructure sectors also manifests in myriad barriers to competition and restrictions on international trade. This also distorts market responses. Poor data availability adds to distortions in representing the reality in IAMs. Besides, in the absence of dependable studies, crucial parameters like price elasticities are often estimated by recalibrating their values from the numbers found in developed countries. This leads to serious errors in analysis.

9) **Non-Economic Concerns:** The logic of current IA is driven singularly by economic efficiency criteria. Notwithstanding the importance of economic efficiency or cost effectiveness, welfare concerns in the developing countries often require explicit government interventions on other criteria such as equity, secondary environmental benefits, food security, administrative

feasibility and political feasibility to carry policies through legislative and bureaucratic processes. IA needs to explicitly consider such non-economic criteria for policy evaluation.

10) **Technological Progress:** A notable feature of developing countries is the co-existence of diverse technologies. The traditional sectors sustain primitive artisan technologies, side by side with modern technologies. The representation of technological progress is complicated by factors such as: i) *diverse technology mix* engendered by the dual economy, extreme variation in incomes and non-competitive technology markets, ii) *high technological inertia* resulting from the shortage of capital and existence of secondary technology markets which breed the co-existence of numerous technology vintages, and iii) *potential for rapid technological progress* in the short run through the transfer of advanced technologies. The equilibrium models within IA framework are too inadequate to capture the above aspects and truly reflect the technological processes in developing countries. This restricts IA from carrying out any substantive technology policy analysis, an issue very high on the agenda of the developing country policy makers. Another vital future agenda for IA would be to realistically represent the dynamics of technological transitions in developing countries.

11) **Exploration of Alternate Development Paths:** The UNFCCC exhorts in its statement of objective that policies for stabilizing GHG concentrations level should *enable economic development to proceed in a sustainable manner* (UNEP/WMO, 1992). The choice of development path is vital not only for human welfare in general, but also for climate change mitigation. Market forces prompted development to go along a high resource intensive and unsustainable pattern in the industrialized countries. The developing countries have an opportunity to take alternate development paths. They are set to take major investment decisions in the coming decades. This opportunity can be used to shift development (Hourcade, 1993; Shukla, 1996a, Loulou et al., 1997) to a low resource intensive trajectory by making: i) adequate infrastructure investments such as in rail transport, communications, renewable resources, ii) following planned industrialization strategies that require much less logistics, iii) influencing consumer behavior, and iv) investing in people. The markets have proved to be too myopic to arrive at such choices. These decisions are vital as they direct development along an irreversible path. The technology trajectory and *technological knowledge grows in distinctly path dependent ways* (Rosenberg, 1994). Technology investment decisions thus tend to lock economies along a path with a specific resource consumption and emissions intensity.

Superior technological and developmental choices are now available to the developing countries. These provide a “window of opportunity” to leapfrog the developed countries in sustainable practices. IA will prove more useful if it will analyze major bifurcation pathways (Hourcade, 1993) that alter the development pattern rather than market policies alone. Although market dynamics ensure economically efficient choices, they often reject options along the alternate development pathways which are superior on other criteria like equity, implementability, conservation of resources, preservation of environment, biodiversity and cultural diversity. Developing country response to climate change will greatly benefit by explicitly assessing the developmental choices like investment in education, demographic measures, institutions, infrastructure, employment, consumer education, sustainable agriculture, land use planning and decentralization. IA studies need to analyze bifurcation scenarios representing a package of options along alternate development paths.

### Socio-Economic Issues of Climate Change Impacts

It is well recognized that human induced climate change will add an important additional stress to ecological and socio-economic systems which are already burdened by other stresses like pollution and unsustainable management practices (IPCC (WGII), 1996). While greenhouse emissions, which induce climate change, originate from the identified human activities, impacts

arise from a multitude of complex climate phenomena which are difficult to pinpoint or forecast. The climate change impacts are most severe on the vulnerable ecosystems and populations, such as coastal area fishing communities, traditional farming communities or tribes living in forests in developing countries. The poor are more affected by the climate change impacts on ecosystems since they are more dependent on natural ecosystems for livelihood and existence.

Many IA studies follow a cost-benefit framework. The costs of climate change mitigation actions are balanced against the benefits of mitigation. In the process, mitigation and impacts are integrated and assessed within a single framework. Due to its energy connection and direct economic implications, GHG mitigation has received more attention in the IAMs than impacts. This is especially true for the developing countries, where several mitigation studies have been undertaken lately (UNEP, 1993; Shukla, 1995; Halsnaes, 1996), however such impact studies are still scarce. Due to uncertainties of their occurrence and unidentifiable origin, the impacts are much less studied. The socio-economic dynamics pertaining to impacts are even less understood.

1) ***Development and Adaptation:*** It is recognized that successful adaptation to climate change impacts *depends upon technological advances, institutional arrangements, availability of financing, and information exchange* (IPCC (WG II), 1996). The adaptive responses are thus development dependent. Low capabilities to adaptation arise from institutional weaknesses, lower prospects for mobility and the inability to commit resources for mitigation of impacts. Existing traditions bind people to social and economic practices which are not costless to change. The less developed regions and communities are doubly vulnerable to climate change impacts. They are more dependent on natural ecosystems. Simultaneously, they lack the resources, institutional and technological capabilities and the technical and social infrastructure to effectively adapt. The small island countries and developing countries in tropics are likely to be the most vulnerable due to their high impacts potential and inability to cope with climate change. The IPCC Second Assessment Report (IPCC(WGIII), 1996) aptly reminds that: *Countries are not equal in their capabilities to deal with the challenges posed by the climate change.* It is important to recognize this in assessment and policy formulation.

2) ***Valuation of Non-Market Impacts:*** The IA methodology gropes in the dark vis-a-vis non-market impacts. Limited by cost as the sole criterion of effectiveness, the methodology fails to realize that any realistic measurement of impacts would require use of multiple criteria as many impacts may not be readily converted into monetary terms. The apparent contradiction here is that non-market impacts like human misery, loss of social and cultural identity, food insecurity, loss of biodiversity and even environmental degradation do not transact on the market. Their valuation in monetary terms presumes the condition as if these markets existed. This valuation method is similar to that of a man, who in the story, searched for something that was lost in the dark under a lamp post since the light was there.

The controversy on the “*value of life*” is an evident example of valuation problems associated with non-market damages. It is a moot question whether irreversible phenomenon like death or pain are substitutable by money or whether the existence of insurance markets for health or life imply their transactability. Concepts such as the statistical value of life are created to overcome the apparent contradiction of valuing through market something which can not be recreated or substituted through normal economic acts. While the statistical value of life diminishes the emotional facet of the contradiction, it fails to provide the answer to whether non-market phenomenon such as loss of life can be measured in monetary terms. The philosophical debate apart, even monetary valuations of non-market impacts in the IA exercises is incorrect since future income streams and purchasing power parity are overlooked. In developing countries, the problems of valuation are even far greater since insurance markets barely exist. The valuation of non-market impacts is fraught with a triple contradiction. The first

is the dispute about the *substitutability* of money with life or pain or culture or irreversible phenomenon like the loss of a species. The other is the *measurability* of these impacts, since they are not transacted on the market. In the case of developing countries, an additional problem arises from the absence of insurance or other markets where people can reveal their preference trade-offs.

3) **Low Value of Life or A "No regret" Situation?:** The controversy about the assessment of a very low value of life in developing countries is rooted in a conceptual confusion. The contradiction arises from the measurement of non-market impacts, like value of life, vis-a-vis present adaptation practices. For instance, the 1991 Bangladesh cyclone claimed over 200,000 lives (IPCC(WGII), 1996). It would have been possible to save a lot of lives for little cost by proper adaptation measures, or even evacuation and post cyclone aid actions. A simplistic measurement of the value of life from such a instance would suggest a very low value of life in Bangladesh. Similarly, in many developing countries the improvement in road conditions and implementation of road safety measures at a small cost may save many lives or mitigate injuries caused by the accidents. This can also be interpreted to mean a very low value of life.

The present valuation perspective presumes the existence of efficient safety or insurance markets. In developing countries, such markets barely exist. Besides, due to the public good character of road safety or cyclone measures, individuals have little recourse to make improvements. In such instances, there are both the failures of markets as well as of public policy. Such failures are basic to the developing country dynamics. But for them, the developing countries would have been functioning like the developed world, and would not have existed as developing countries at all.

An alternate (southern) perspective would be to presume a value of life which satisfy widely acceptable criteria. For instance, the value identical to that in the developed countries, which would satisfy the egalitarian principle. Events such as the Bangladesh cyclone of 1991, which caused enormous damage to life and property, or the situations such as the hazardous road conditions in most developing countries, can now be viewed as the "no regret" situations where an enormous loss could be salvaged at a little expense. Under this perspective, the Bangladesh cyclone policy or the road safety policy in developing countries are "no regret" options that could be harvested to realize enormous welfare gains. Energy efficiency experts, belonging to IA teams do readily identify the energy inefficiency syndrome in developing countries as a "no regret" phenomenon caused by barriers to the market. It is amazing that the identical situation on the impacts side is however not comprehended. Whereas the energy policy of Bangladesh is presumed to be fraught with myriad barriers, the cyclone policy in Bangladesh is regarded as market efficient and is used to value life. The barriers to market should have been more apparent in the case of non-market impacts like loss of life, since what is traded is itself a non-market commodity. In comparison, the energy markets are more visible. This is not an ordinary oversight but a blunder. Ironically, like the chase for identifying barriers to energy efficiency, the assessment of the value of life is a consequence of a confused view of development. The development again appears as a "chicken and egg" enigma, now chased from the other end.

4) **Damage Function:** Damages are represented in IAMs through aggregate functions. The damages are calibrated as a percent loss to GDP. The bounds on the aggregate function and its form are arbitrarily prespecified. Most often, models then supply the reformatted version of these values as results. Besides this circularity, damage estimates are at best in the ball park and disputable. Most estimates are derived by ad hoc procedures, such as expert interviews. While aggregation often seems elegant from modelling viewpoint, it is of little value for global policy formulation. The global policy requires to identify the mitigation, adaptation and compensation actions locally. National policy makers are most often interested in the results, policies and their implications, as they pertain to their own countries. At the time when global policy makers are

looking for such practical inputs, the ad hoc aggregate damage functions seems to have outlived their purpose. The valuation of damages in developing countries is doubly biased. First non-market damages such as the value of life are valued lower. This aside, while aggregating global damages, values are converted by exchange rates of currencies ignoring the purchasing power parity or future incomes. As a result, damages and the consequent welfare losses from climate change impacts in developing countries are underestimated.

5) **Dual Bias:** A peculiarity of the climate change problem is that impacts are borne by the poor from the emissions largely contributed by the actions of rich elsewhere. This induces dual bias in the valuation of costs and benefits. The mitigation actions, which have to be initiated in the rich nations are valued higher due to the high capital content of their activities and high exchange value of their currency. The benefits from the mitigation of impacts are valued lower as these occur in poorer nations, where incomes are low and currency value is deflated. Inherently, this double bias leads to the conclusion of shifting mitigation actions to developing countries and delaying the actions (Richels et al., 1996; Wigley et al., 1996) since marginal mitigation costs in developed countries are high and the marginal benefits of mitigation in the developing countries are too low. Besides these biases in estimations, these results also reflect scant appreciation of socio-economic dynamics and other concerns of developing countries (Shukla, 1996b).

### **Representing Developing Country Dynamics in IAMs: Future Agenda**

Undeniably, the IA of climate change has made notable contribution, at least to the extent of posing the problem correctly and bringing science and policy on the same platform. IA has shown promise to provide insights and even answers to some of the complex questions posed by a truly global problem. As the negotiations progress towards a global accord, the utility of IA hinges on its credibility and ability to answer questions posed by policy makers. Refining the representation of developing country dynamics in IA shall help in both these regards. A realistic representation of the socio-economic dynamics of the developing countries will make IA much more effective. To overcome these shortcomings, the socio-economic model components within IAMs need drastic alterations.

1) **Transition to Hierarchical Models:** IAMs are monoliths, representing the climate change phenomenon at highly aggregate geographical, sectoral and policy levels. The simplification and aggregation, although elegant from modelling perspective, often miss the rich diversity of real life. The aggregation tends to obfuscate the differences in dynamics at disaggregated levels. The problem with the aggregate models, such as the IAMs, is that the lacunas in the representation of reality renders results worthless for use at the disaggregated levels. Besides, the errors in model specifications lead to conclusions which are irrelevant or even incorrect for specific situations. Although global climate change policies are to be decided collectively by nations, the policies will not be uniform temporally, spatially or sectorally. IAMs therefore need to move away from the monolithic paradigm, towards a hierarchy of disaggregated models which can appropriately capture the diversity and complexities manifested in reality.

2) **Agenda for Refining IAMs:** The agenda, from the developing country perspective, for refining socio-economic aspects of IAMs should consider paying greater attention to: i) land relations and land use, ii) demographic transitions, migrations and their impacts, iii) accounting of informal activities and their dynamics, iv) differentiation of production function for the same commodity in traditional and modern sectors, v) evolving consumer preferences, vi) disequilibrium in markets, vii) sectoral and regional details, viii) accounting of traditional biomass consumption, ix) non-economic criteria like inter and intra generational equity, justice concerns, food security and political feasibility, x) specific aspects of technological progress

such as high technological inertia in traditional systems and leapfrogging possibilities through technology transfer, xi) integrating climate change policies with other developmental policies, such as the infrastructure investments and industrial location which shall alter the long term resource use pattern, xii) impact on competitiveness of national industries, xiii) social and political inertia of policy implementation, and xiv) uncertainties arising from social and political processes.

The credibility of IA will be enhanced through the following: i) *procedural transparency*, e.g. the involvement of diverse group of experts and policy makers to discuss and decide crucial parameters like the value of life, assessment criteria, uncertainties etc., ii) *structural transparency*, e.g. the model assumptions and structure, iii) *paradigm acceptance*, i.e. communicating the IA paradigm to users and securing their acceptance, iv) *regionalization*, e.g. capturing regional specificities to enrich the assessment and make results acceptable and implementable, v) *adding diversity*, e.g. the socio-economic processes, dynamics and structures in developing countries, vi) *hierarchical modelling* instead of a monolithic, all encompassing single model, vii) *purposive* (or minimum) modelling, i.e. making IAMs responsive to answer specific policy questions rather than operate as general truth machines.

3) **Refining Assessment Criteria:** Equally, refinements, transparency and dialogue are needed in deciding the criteria for the assessment. GDP as a measure of welfare is amply criticized. Global development agencies, like the UNDP, have already developed indices like the Human Development Index (HDI) to measure welfare (UNDP, 1996). Such indices are widely accepted by the global and national policy community. The IAMs have lagged too far even to include such known measures. This is not surprising since the economic viewpoint of IAMs is governed by neoclassical economists from developed countries, who are not only unaware of the realities of developing countries but are also ignorant about the vital debates on development. The results of IAMs will continue to lack credibility unless a comprehensive welfare index is developed through a transparent process.

4) **Database Improvement:** An often encountered problem for good assessment in the developing countries is the availability of relevant data. Six basic data related problems are: i) *unavailability*, i.e. data was not collected or can not be reconstructed from other information, such as, for instance, informal transactions, ii) *disparity*, i.e. the data is not compatible across regions or sectors, such as, for instance, sectoral data is available across regions at different levels of aggregation, iii) *inconsistency*, i.e. data is collected by different procedures or assumptions across sectors, regions or time periods, such as, for instance, the estimation from the consumption side in one time period and from the production side in the other period, iv) *incompatibility*, i.e. the use of data presumes conditions which did not exist in reality, for instance market equilibrium, v) *unsuitability*, i.e. data is not collected to suit requirements, like the particular assessment framework, vi) *incomparability* of results, i.e. the use of dissimilar data types and sources which makes the results of different IA exercises incomparable.

Data consistency and adequacy deserve special attention in IA, since the data are spread over a long period of time and space and are collected from diverse sources. The tendency to substitute the data gaps by opaque assumptions poses a serious threat to the validity and credibility of IA. It is difficult and expensive for each IA research team to overcome the data problems. The preparation of a consistent, comparable and adequate database for IAMs is an important agenda for IA. This can be achieved in a short period and at a low cost through the pooling of data by global IA research teams, including modelling teams from the developing countries.

## **IAMs: Drawbacks, Lip Service and Myths**

The promise and expectations from IA have remained unfulfilled primarily due to the inability to overcome the apparent drawbacks. As a result, the IAMs researchers have tended to be defensive and even apologetic about the results or to pay only the lip service to some crucial concerns.

1) ***A Myopic World View:*** Dominated by the northern perspective, the IAMs remain poorly specified with the socio-economic dynamics of developing countries. Blinded by this myopic vision of neoclassical economic models, IAMs have groped in the dark about development processes and continue to be haunted by myriad anomalies, enigmas and paradoxes. Since the role of developing countries is vital in future climate change policies, lip service is often paid for considering the specific aspects of developing countries within IAMs. In practice however, little is done in the IAMs to improve representation of the socio-economic dynamics of developing world or to analyze their specific concerns. The resistance to change is understandable. The new perception requires to go beyond the limited northern view of world dynamics, a terra incognita for the northern researchers.

2) ***Lip Service to UNFCCC and SAR:*** The IA studies pay the lip service to the UNFCCC by selectively referring to a statement of principle in the Article 3(3), which declares the cost effectiveness as a vital measures of assessment: “..... *policies and measures to deal with climate change should be cost effective so as to ensure global benefits at the lowest possible cost....*”. At the same time, many other statements of UNFCCC are conveniently ignored, like the statement of objective (Article 2) which asserts that the stabilization should be “.....*achieved within a time frame sufficient to allow ecosystem to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner*” or the principle in Article 3(2) which expounds that: “*The specific needs and special circumstances of developing country Parties ..... should be given full consideration*”.

Equally overlooked are the conclusions from the IPCC Second Assessment Reports (SAR) such as: “*The data and understanding of critical processes in the 140-odd non-OECD countries are more limited*” or “.....*better understanding and modelling of land use, land tenure and population growth in the developing countries will alter the insights regarding the climate change problem and potential policy responses to it produced by the current set of aggregate integrated assessment models is an open question*” (IPCC(WGIII), 1996).

3) ***Climate Change Policy or Panacea?:*** An argument often made by neoclassical economists against a wider perspective of assessment is that climate change policy can not be a panacea for all socio-economic problems. The same economists, while using the IAMs, precisely do so. The solutions of IAMs are integrated and comprehensive. Climate change policies are embedded within economic policies such that the IAM results provide precise prescriptions for economic policies, demographic policies, agricultural practices, forestry practices, technology and infrastructure investments and many other sectoral and subsectoral policies. The implications of IAM solutions are also pervasive, in the sense that while proposing optimal climate change actions, the models also tell what developmental paths countries should follow in the future. For instance, the IAMs suggest all developing countries to follow market oriented reforms. It is well known that such reforms are not costless. The governments of different developing nations have exhibited diverse preferences towards the pace and pattern of economic reforms, depending on their socio-economic and other conditions. Implicitly, the results of the IAMs override these diverse responses across the countries and regions with a uniform package of policies and practices. The world dynamics are thus imposed everywhere, in the image of the north. Market efficiency becomes a panacea for solving the problems of

poverty and climate change simultaneously. The solutions from IAMs inadvertently go beyond the predefined climate change agenda and become panacea for all problems.

4) ***Integrity of IAM Results:*** The IAM results are integral, i.e. the policies prescribed are meaningful only when implemented in totality. Partial or selective implementation of policies will be far from optimal. The implementability of specific policies depends on their correspondence with local conditions. It is essential to ensure that during aggregation, details are not overlooked. The present IAMs are very poorly founded for this purpose, especially in terms of representing the developing country realities. It is sometimes believed that since IAMs consider only the aggregate phenomenon, the errors from overlooking details like poor representation of developing country dynamics shall cancel out or will make only marginal difference. In reality, the errors have tendency to accumulate. More pertinent is to note that the aggregate results are “good” only so long as they can be disaggregated into implementable policies and practices. Details must not therefore be overlooked. Most often, the national policy makers are more concerned with the implications of policies to their own domain. An ideal policy framework would require the complete correspondence between representation at the aggregate level and dynamics at the disaggregated levels. The IAMs are yet very far from such an ideal.

5) ***Myth of Insights Versus Results:*** A myth among the IA researchers is that the results from IAMs are not important, only the “insights” are important. This myth is often used as an apology for the results. It just reflects a lack of confidence in the results, or the process of obtaining the results or their practicality. Often, the “insights” are only the reformatted versions of input assumptions. For instance, the “insight” that the co-operation on climate change among the nations is cost effective or the other “insight” that locating mitigation actions in developing countries shall be cost effective, are but the reformatted versions of input assumptions and peculiar data. Complex IAMs are not needed to discover such “insights”. While it is true that the model results need not be followed to the last digit, it is also equally true that the models which give far from acceptable results can scarcely provide insights. The model results and insights are most often inseparable. Even the insights gained from the scenario analysis are valid only so far as the scenario results are sound. Insights versus results debate is a subterfuge to skirt the issue of finding and correcting the drawbacks of models. Policy makers need the results as much or more than the insights. Implementable policies and negotiations are not made from insights alone. As the global climate change negotiations near the stage of formulating concrete accords, policy makers are more concerned with credible results and implementable policies from the IAMs than general truths appearing as “insights”.

6) ***Myth of Caveats:*** Another prevailing myth among modellers is that by placing caveats, an analyst or the framework of analysis is absolved of all shortcomings. Caveats are important for transparency. While a well caveated report suggests more honesty, it also signifies little efficacy. The caveats demonstrate the extent to which the methodology is unable to address underlying issues. The reduction in caveats over time is one good measure of the advancement of a methodology or a model. IAMs have made little progress in this regard, especially in terms of the caveats on representation of developing country processes. IAMs need to overcome the drawbacks inherent in the caveats and thereby become more realistic and effective policy tools rather than remain honest (well caveated) but ineffective instruments.

7) ***Myth of Potential Versus Realizable Gains:*** Another myth around the results of IAMs is that they only discover the potential gains from the alternate climate change strategies. This myth originates first from the neglect of details in the aggregate IAM analysis and then from inadequacy to consistently disaggregate the results. The disaggregation problem arise from the mismatch between the aggregate assumptions and the disaggregated reality. If assumptions vary widely with the reality, then the potential remains unrealizable. To the extent that aggregate



model dynamics are realistic, the gains are at least theoretically possible to be realized. In situations where the model dynamics are far separated from reality, the potential gains are illusory. They exist only as model results. The difficulty with many IAM studies is that due to the weak representation of reality, the potential gains which are proudly pronounced as "insights", are illusory and belong only to the model domain. The difficulty of realizing the potential lies not in the practical barriers, but their non-existence in reality. Unless the disaggregated reality is adequately represented in the IAMs, the potential gains will be either illusory or at the best remain unrealizable and the results of IAMs will acquire no practical utility for policy making.

### **Conclusions: Towards a Credible and Implementable Assessment**

Some achievements and promise notwithstanding, the present art and science of IA needs to be improved and reoriented to become credible to scientists as well as the policy makers, and for its results to be implementable. The integration capabilities of IAMs, which blend economic models of the greenhouse gas mitigation and impacts with scientific models such as carbon cycle and sea level rise, are admirable. Many shortcomings in IAMs have entered through the disciplinary models. Integration can not resolve these problems nor add realism lacking in the disciplinary models. The lacunas from disciplinary models are magnified in IAM applications. The basis lacunas must be corrected at the discipline level. IAMs are too top heavy and need to be strengthened with disaggregated bottom-up models. Dominated by the neoclassical economic paradigm, IAMs have continued to ignore some vital aspects of socio-economic dynamics of developing countries. As climate change policy making nears the concrete accords, there is a need for a robust IA paradigm. This will require: i) decentralized, disaggregated and hierarchical modelling instead of the current highly aggregate and monolithic modelling, ii) procedural transparency to decide the values of input parameters, iii) structural transparency to decide model assumptions and structure, and iv) purposive orientation of IA exercises to address practical concerns of policy makers.

A new IAM paradigm must be better rooted in the social and political realities and link climate change policies with the wider sustainable development concerns, such as attempted in the models like TARGETS (Rotmans et. al, 1994). The IAM paradigm will then become truly integrated and IAMs will become sharper and credible tools to assist the policy makers to address wider concerns such as those exhorted in the UNFCCC principle (Article 3(5)): "*The parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change*".

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