6. Conclusions

The equity approach towards environmental sustainability is based on the logical extension of the notion[22] of *social equity between generations* to that of *equity within generation*. The principle of common but differentiated responsibility enunciated in the UNFCCC as well as the Kyoto Protocol and the concept of convergence of per capita emissions are in consonance with this approach. Implementation of this concept in a fair and reasonable manner has been attempted to arrive at mitigation targets post-2012.

The approach is generalized and can take into account emissions from any chosen baseline period. The year 1990 has been chosen as the baseline year in the sample projections thereby ignoring the impact of historical emissions prior to that year. A major advantage of the method is that it can easily be adapted to take into account the emissions trading regime also as these can be factored into the responsibility functions which are derived from cumulative excess emissions and GDP projections.

The consensus on emission reduction targets have proved extremely difficult and time consuming to arrive at during various negotiations. The two agreements of the Rio Earth Summit, 1992, namely, the Framework Convention on Climate Change and the Convention on Biological Diversity, were accompanied by much bickering and procedural wrangling among the countries on

[22] See *World Commission on Environment and Development* (1987) for a detailed discussion of sustainability which rightly states that 'our inability to promote the common interest in sustainable development is often a product of the relative neglect of economic and social justice within and amongst nations.'

account of deep-seated disagreements (Read, 1994). The Kyoto protocol took about 4 years after the United Nations Framework Convention on Climate Change entered into force on 21 March 1994 and it took further about 8 years for the Kyoto Protocol itself to come into force on 16 February 2005. The current experience with the Copenhagen conference is no different which at best yielded some solemn promises of voluntary action.

In the context of increasing threat of global warming, the voluntary approaches adopted in the Copenhagen accord are unlikely to lead to any substantial action for climate change mitigation. The seriousness of the problem would, no doubt, force the global community to adopt firm and emergent approaches towards emission reduction apportionment in the near future. The only solution for this predicament appears to be to firmly ground the approach on fairness and equity. Methodologies built on the basis of these principles would have to be instituted for apportionment computations which would modify the responsibilities on real time basis as action plans unfold in various regions.

Since the commitments in Copenhagen are insufficient to limit global average temperature rise to an acceptable level of 1.5 to 2°C above pre-industrial levels, the world will have to grapple with more and more damaging impacts of warming. Though the architecture of the Copenhagen Accord is more flexible, it might prove ineffective in protecting the climate good from the tragedy of the commons. This will necessitate the search for consensus principles which are enforceable, as the risks start weighing down on the countries. Global challenges such as climate change will hopefully necessitate a moral evolution in collective thinking,

where moderation and sustainability take precedence over unlimited wants and diminishing marginal utilities. Meanwhile, it would increase the significance of adaptation measures which would be a reminder to the collective psyche that even the universally accepted principle of 'prevention is better than cure' is extremely difficult for consensual implementation in the arena of the international politics of national interests.

Yet, it appears inevitable that when nature cracks her whip, the mighty will be humbled to obey. When the risks become obviously apparent even to the skeptics, collective consensus is likely to emerge based on universal principles. The preset framework could be a useful choice in a situation of similar competing frameworks, which need to be assessed on the basis of appropriate criteria such as acceptability of the principles, simplicity, ease of implementation, ease of securing consensus on data, ease of duplication and comprehension, practicality of the approach etc.

The 'Contraction and convergence' approach and the 'Princeton proposal' are two such frameworks. In comparison to the 'Princeton proposal', it is seen that the dual principle approach is relatively more stable and well-distributed. These outcomes are on account of the fact that the distributions are arrived at based on two separate variables representing two logical principles related to apportionment, for which independent data are available. The share of OECD increases under the dual principle approach compared to the Princeton proposal on account of the consideration of convergence of entitlement as well as the historical emissions. While India's share is almost identical in both regimes, China and Africa gets a higher commitment under the Princeton

proposal. The share of USA remains comparable under both evaluations.

Methodologically, the procedure outlined above requires consensus on baseline emission scenarios as well as GDP projections for the mitigation period. However, since the computations would be on a continuous and real time basis, any actual variations from the baseline projections as well as variations in mitigation achievement levels can be factored into the calculations by modifying mitigation responsibilities accordingly in future. This would, however, be the smaller of the concerns in an apportionment framework as sustainability challenge would demand consensus more on the principles of approach than on the methodologies of implementation.

The principles would face challenge from the fact that the GDP of some countries are highly dependent on fossil fuels which are traded and the consequent emissions are in other countries. This may reduce the mitigation responsibilities of the oil/coal exporting countries to some extent and correspondingly accentuate those of importing countries. However, consuming countries can partly offset this problem by the choice of policy instruments which utilize demand elasticity so that the burden is shared by the producers also through market mechanisms. Another aspect is the fact that historical emission data takes into account carbon sources and not sinks. For example, forestry sector has dual roles of a sink and a source on account of the carbon sequestration by plants and the emissions from deforestation and degradation of forests.

The issue of carbon sinks is controversial[23] on account of the uncertainty of determining the quantum of absorption as well as the time period of fixation. Nevertheless, an appropriate consideration for carbon sinks can be built into the proposed framework by introducing a suitable correction factor into emissions trajectories to account for this effect in the computation of mitigation responsibility. The issue of population as a driving factor of emissions has been partially accounted for by considering the entire national GDP as an emission reduction responsibility factor, without considering population based entitlements. If this entitlement is allowed, it would reduce the emission reduction commitments of populous countries like China and India further.

The methodology can be generalized to include any other relevant factor by suitable modification of the responsibility function. If considered necessary, more variables could also be introduced into this function. This would, however, increase computational complexity. The generalized framework could also be extended to situations involving responsibility apportionment in public policies dealing with externalities.

As far as the interface of the framework with climate modeling is concerned, it may be mentioned that climate being long term and highly nonlinear, the interrelationships among climate variables are extremely complex. A period of 30 years would at least be required to arrive at any valid conclusions regarding climate variations. However, simple zero dimensional models are very useful in arriving at useful estimates for policy planning. This

[23] See Dresner (2005) p.55

framework uses such simple models to estimate the relationships between greenhouse gas concentration and temperature, stabilization rate for emissions at a future year etc. Even extremely complex models give highly uncertain results as the projections extend farther into the future. Therefore, though the present framework has been configured to indicate trends up to 2100, the projections beyond 2060 are likely to be highly subject to the limitations of unpredictability and uncertainty, particularly on account of the simple, empirical, and zero dimensional models.

As regards achievement options for emissions reduction, it involves building stabilization wedges as suggested by Pacala et al.(2004) where a wedge is defined as 'an activity that reduces emissions to the atmosphere that starts at zero today and increases linearly until it accounts for 1 GtC/year of reduced carbon emissions in 50 years.' In the Indian context, several activities relating to energy efficiency, water efficiency, urban design, mass transport etc can be identified each of which alone or in combination results in centiwedges(cw) improvement (that is, reduces 0.01GtC/year or about 36 MtCO2/year).

Though India has a very high potential to reduce emission intensity of its GDP, it requires substantial investments. World Development Report (2010) estimates that limiting global emissions to 450ppm requires an additional annual investment of $40 billion to $75 billion for India (1.2-2.2 percent of GDP) in 2030. Compared to this requirement, developed countries have committed only an amount of $100 billion per year by 2020 for all the developing countries, according to the Copenhagen accord. It is obvious that effective climate change mitigation would require substantial

financial and technological transfers from developed countries to developing countries including India.

Though financing and technology are the vital links for global climate change mitigation, both are not strongly in place to challenge the problem. It is required to put in place a Climate Change Mitigation Facility as suggested[24] in the Human Development Report (2007/2008) which would address the issues of mobilization of finance, Mitigating risks, Building technological capabilities, buying out intellectual property and Expanding access to energy.

[24] See Human Development Report(2007/2008) p.156 for details