Energy and Climate Change: A Just Global Compact

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Abstract

At the Copenhagen conference a consensus on an action plan has to be reached if mankind is to deal effectively with the threat of climate change. The delay in taking serious action may have already made attainment of stabilization at 450 parts per million (PPM) beyond reach. Any further delay would be disastrous for many people. The Annex 1 countries insist that before they act some of the large non annex 1 countries (NACs) such as China, India, Brazil, Mexico and South Africa also accept some commitments. To reduce emissions is to reduce energy consumption. The NACs need energy for growth and poverty removal. India, for example, needs to grow at 8 % for a number of years to deal with poverty. Also India has not contributed anything to the build up of CO2 concentration in the atmosphere. None the less India in its own interest would want to follow a low carbon growth path and would agree to any just compact. By raising this issue of NACs, the annex 1 countries are delaying action and have been free riding on the developing countries. We need an agreement that ensures equity and expeditious action on climate change by all. A scheme to charge rent on a country's accumulated emissions of GHGs since 1990 by all countries with proceeds distributed to countries on equal per capita basis as per their 1990 populations as an ethically just compact to arrest climate change. This will be an efficient mechanism, consistent with UNFCCC and will encourage negative emissions.

Key words: Rent, equity, environmental space, justice, cumulated emissions, carbon tax, India's energy options

1. Introduction

There is a large scientific consensus that the climate change threat is real and we need to act now. Even if the probability is low, precautionary principle suggests that we take action.

At the Copenhagen conference a consensus on an action plan has to be reached if mankind is to deal effectively with the threat of climate change. The delay in taking serious action may have already made attainment of stabilisation at 450 parts per million (PPM) beyond reach. Any further delay would be disastrous for many people.

At the preparatory CoP (Conference of Parties) meeting in Bonn in June 2009, some critical issues are on the table (UNFCCC, 2009). Among these are: What should be the

stabilisation level of GHG concentration, 450 PPM or one that limits temperature increase to 2 degrees Celsius above pre-industrial level? Also on the table are issues of per capita accumulative emission convergence and equitable allocation of the global atmospheric resources.

Under the United Nations Framework Convention on Climate Change (UNFCCC) accepted at Rio annex 1 countries (A1Cs) were required to bring their emissions to 1990 level by the year 2000. This very modest target was not reached. Also there is no enforcement mechanism in the UNFCCC and the rest of the world could do very little but watch helplessly as the rich occupy the global environmental space. It is now widely recognized, what we had pointed out in 1991, that the threat to climate is largely due to unsustainable consumption pattern of the rich and not due to growth of population as such. A world of only 6 billion persons all consuming and emitting GHGs at the level of a US citizen would emit as much as 120 billion tones of CO_2 equivalent. On the other hand, 12 billion persons emitting at the rate of an average Indian citizen would emit only 12 billion tones of CO_2, way below earth's absorptive capacity. This is not to argue that all the persons in the world should live like an Indian citizen, but to emphasize the importance of consumption pattern. The consumption pattern of the rich is aspired to by others today.

At the same time under UNFCCC, the non-annex 1 countries (NACs) were free to increase their emissions and had no incentive to be GHG emission efficient. Some of them have crossed per capita emission levels of some annex 1 countries, but there is no mechanism to make them restrain their GHG emissions.

A1Cs insist that before they act some of the large NACs such as China, India, Brazil, Mexico and South Africa also accept some commitments. The NACs are not uniform and differ widely in their need for development as well as their emission levels. Even when one accepts that some action is called for by NACs, how much of it and by who among them are issues that need to be examined. By raising this issue of NACs, the annex 1 countries are delaying action. Through delays A1Cs have been free riding on the developing countries (Parikh J. and Parikh K. 1997).

I first show how unreasonable is the insistence of A1Cs that India accepts some commitments by looking at India's energy needs and options and what she is doing for climate change. Then I argue that the atmosphere is a parking space for GHG emissions. Nobody vacates a parking space unless she has to pay for it. A1Cs have been increasingly occupying this space as they don't have to pay for it. Based on this I describe a mechanism that ensures equity and expeditious action on climate change by all.

The paper is organised as follows: In Section 2 I summarize India's energy needs and GHG emissions. Section 3 describes India's action plan for climate change. In section 4 I argue that allocation of emission quotas is inescapable. In section 5 I explore some principles of fair and just allocation. Section 6 suggests a just global compact that provides incentives to all including the non-annex 1 countries, to act in a carbon efficient manner for mitigation and adaptation. Finally section 7 concludes.

2 India's Energy Needs and GHG Emissions

The total primary energy supply (TPES) in 2005-06 in 2005-06 was 510 Mtoe (million tones of oil equivalent) in India. The energy mix was largely dominated by coal and consisted of Coal and Lignite (37.9%), Traditional bio-mass (28.6%), Oil (23.9%), Gas (6.9%), Hydro (1.7%) and Nuclear (1.0%). On the other hand total primary commercial energy supply (TPCES) was 365 Mtoe in 2005-06. India's share of global commercial energy supply in 2005 was 3.7%. Top 5 consume over 50% led by US at 22.2% and China at 14.7% followed by Russia, Japan and Germany. India's per capita commercial energy consumption is about 20% of the world average, 4% that of the US and 28% that of China.

Indian economy is growing at more than 8% per year. With 8% average growth over 25 years India's electricity requirement is projected to grow as follows:

Table 1: *Projections for Electricity Requirement*

Year*	Billion kWh		Projected Peak Demand (GW)	Installed Capacity Required (GW)
	Total energy Requirement @ GDP Growth Rate	Energy Required at Bus Bar @ GDP Growth Rate	@ GDP Growth Rate	@ GDP Growth Rate
	8%	8%	8%	8%
2003	633	592	89	131
2006	761	712	107	153
2011	1097	1026	158	220
2016	1524	1425	226	306
2021	2118	1980	323	425
2026	2866	2680	437	575
2031	3880	3628	592	778
* Financial Year : India's Financial Year 2009 refers to				
Source:	*Parikh K.S., et al* (*2006*)			

Table 2: *India's Energy Requirement*

Fuel	Range of Requirement in Scenarios	Assumed Domestic Production	Range of Imports#	Import (Percent)#
	(R)	(P)	(I)	(I/R)
Oil (Mt)	397–555	35	362–520	91–94
Natural Gas (Mtoe) including CBM*	125–235	100	25-135	20-57
Coal (Mtoe)	860-1296	560	300-736	35-57
TCPES (Mtoe)*	1667-2077	-	972 -1382	58-67

*CBM - Coal Bed Methane; TCPES – Total Commercial Primary Energy supply;
Mtoe – Million tones of Oil Equivalent

Range of imports is calculated across all scenarios as follows:
Lower bound =Minimum requirement – Maximum domestic production
Upper bound = Maximum requirement – Minimum domestic production

Source: *Parikh K.S., et al 2006*

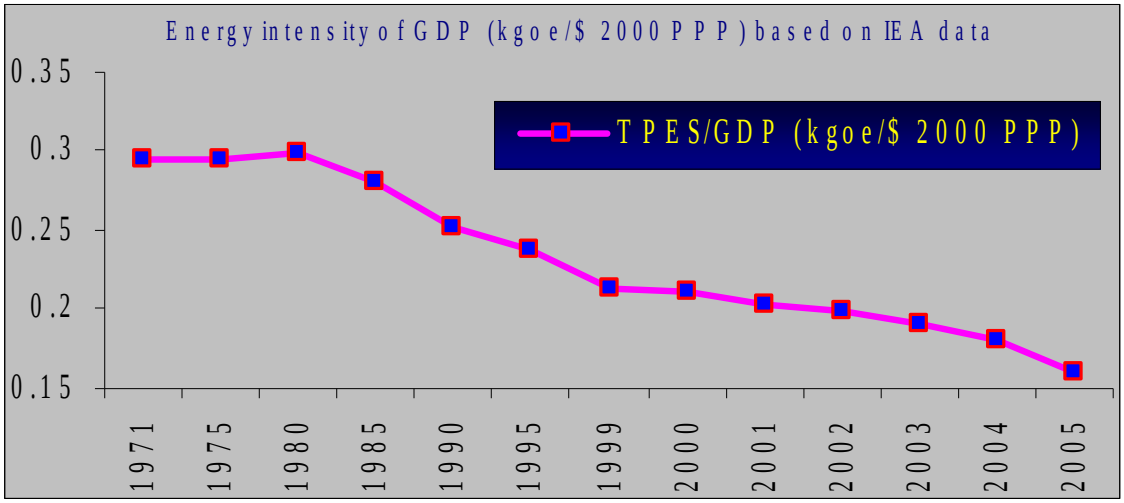
The energy requirement can be met through various means under alternative scenarios including one in which conservation, efficiency and renewables are pushed vigorously and in which hydro and renewables meet 20% of total primary energy requirement. These indicate energy requirements as follows:

India's primary energy supply has to grow by 4.6 – 5.46% to reach 1667 to 2077 Mtoe by 2031-32 for GDP growth of 8%. Then India's share of world fossil fuel supply, which in 2005 was 3.7%, could become 7.6% to 10.9% by 2031-32. India's incremental requirement could account for 12-19% of the world's incremental supply by 2031-32. India would need to tap all available energy supplies and pursue all available and emerging energy technologies.

India is an efficient user of energy. Its energy intensity per 1$ worth of purchasing power parity (PPP) adjusted GDP was 0.16 kgoe/$GDP PPP 2000 in 2005, compared to 0.17 for Germany, 0.22 for USA, 0.23 for China and 0.21 for the world.

Also India's energy intensity is falling and has come down from nearly 0.3 in 1971 to 0.16 by 2005. See *Figure 2*.

Figure 2: *India's Energy Intensity Falling*



As a consequence India's CO_2 emission intensity is also falling (See *Table 3*). Between 1999 and 2005, Indian GDP grew at 9.1 percent/annum, but CO_2 emissions grew only by 3.7 percent/annum showing a fall in emission intensity of 4.9 percent/annum.

Table 3: *India's Emission's Performance*

	1999	2005	CAGR(%)
GDP US$ Billion PPP	2242.0	3779.0	9.1
Emissions MT of CO_2	934.8	1165.7	3.7
Kg of CO_2/US$GDP PPP	0.42	0.31	-4.9
Source: EIA & UNDP, HDR (2007)			

Considering that India emits only1/5th the total emissions of China and of United States and 1/10th that of United States in per capita terms, it is misleading to lump India and China together.

India can argue that it has not contributed anything to the build up of Co2 in the global atmosphere. The absorptive capacity of global environment is around 15 bt of Co2 per year. If this is allocated on a per capita basis India's share would be 2.5 to 3 bt/year even if the shares are fixed on the basis of populations of 1990. Then Fig. 2 shows India's cumulative emissions growing at 4.6 percent per year since 1990 along with its cumulated share in absorptive capacity. It is clear that only after 2040 India's cumulative emissions exceed its cumulative share in the global absorptive capacity.

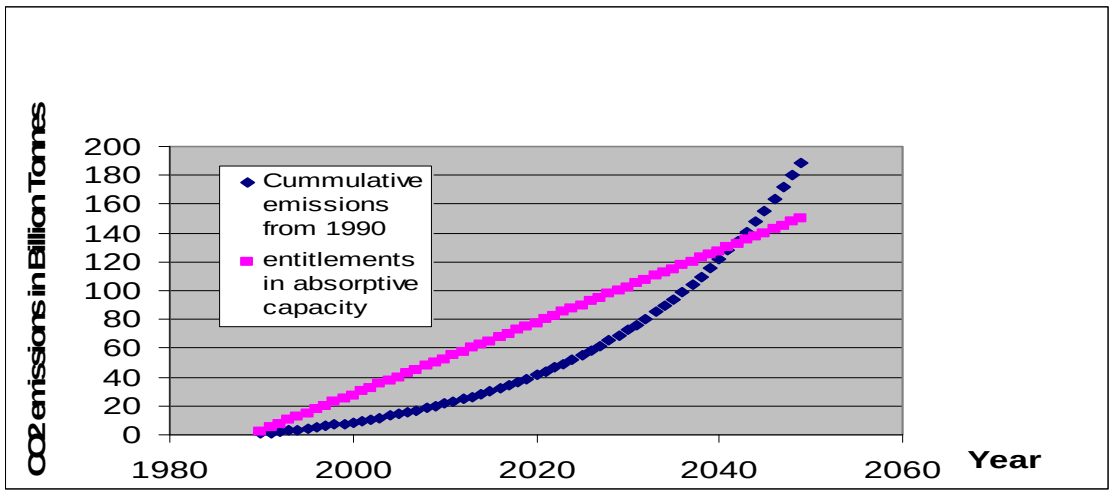


Figure 2: India's Cumulative CO2 Emissions and its share in Global absorptive capacity

Thus India has little responsibility to take any mitigation commitments. Yet India is highly vulnerable to climate change and has significant interest in effective global action.

3. India's Approach to Climate Change

It is obvious that India has not contributed anything to the threat of climate change and is not responsible for it. Yet India is extremely vulnerable to climate change. Also as a responsible nation India has taken initiative to stimulate action on climate change. Thus Prime Minister Manmohan Singh stated at the Heiligendamm Conference of G8 and Five Heads of State that—

> "*We are determined that India's per-capita GHG emissions are not going to exceed those of developed countries even while pursuing policies of development and economic growth*".
>
> ……
>
> "*We must work together to find pragmatic, practical solutions, which are for the benefit of entire humankind*".

The implications of this are worth noting. It implies a huge commitment. If global warming is limited to 2°C, it implies stabilization at 450 PPMV concentration of GHGs. This in turn requires 80% to 90% reduction by industrialized countries by 2050. Thus their per capita emission would be around 2.5 t of CO_2/year. In the scenario with all energy efficiency measures and promotion of renewables, India will reach this level of per capita emission by 2030. Its future growth would have to see that by 2050 India does not exceed this. The ball is in the industrialized countries. The more they reduce their emissions, the lower the limit India will accept on its emissions. India should no longer be used as an excuse by industrialized countries for delaying mitigation action.

3.1. India's Action Plan

The Prime Minister's Council on Climate Change has recently published India's Action Plan for Climate Change. It puts high emphasis on efficiency and conservation with focus on energy efficiency in all sectors; emphasis on mass transport; active policy on renewable energy including bio-fuels and fuel plantations; accelerated development of nuclear and hydro-electricity; technology missions for clean coal technologies; and focussed R&D on many climate friendly technologies.

Also to get concerted and concentrated action eight national missions are envisaged to coordinate action across different ministries, stakeholders and institutions. These are missions to develop and promote:

- Solar energy;
- Enhanced energy efficiency;
- Sustainable habitat;
- Water conservation and management;
- Sustaining the Himalayan ecosystem;
- Greening India;
- Sustainable agriculture; and
- Strategic knowledge for climate change

India is following the advice of its Nobel Laureate Poet, Rabindranath Tagore:

"Even if no one responds to your call nor follows you, go alone"

It is sometimes argued that even though per capita emissions of India and other Non-Annex 1 countries are low, India's industries compete in the world market and so we should have sectoral standards for emission. There are many difficulties in implementing sectoral standards. What should be compared? CO_2 per tonne of product, CO_2 per dollar worth of output or CO_2 per unit value added? Should we take sectoral averages or only consider new capacity? Should we account for specific circumstance of a country such as ambient air temperature, which affects fuel efficiency of a machine or a plant? If a country has a relatively clean air which can absorb more pollution than another country this is the country's comparative advantage, just as skilled labour, large capital stock or technological knowledge give comparative advantage. Sectoral standards thus contradict the very basis of free trade.

There is thus no reason for A1Cs not to act. We must get a fair and just global compact in Copehagen.

4. Allocation of Emission Quotas is Implicit in All Alternatives

Apart from action by non-annex 1 countries, many ideas have been floated for an agreement to reduce GHG emissions. Among these are: Continue along CDM with much deeper cuts by A1Cs; Get developing countries to take measurable verifiable actions under Nationally Appropriate Mitigation Action (NAMA) with finance and technology provided by A1Cs; Levy a global carbon tax; Have a cap and trade agreement under which countries will be

given a cap (an upper limit) on what they can emit and emissions above the cap have to be purchased from a country that emits below its cap. The main problem here is how does one determine caps by countries? A cap is an allocation of emission right to a country.

In fact the Kyoto Protocol also is a cap and trade arrangement, where caps were provided on annex 1 countries and they were permitted to trade among themselves as well as with non-annex 1 countries on whom there were no caps. Thus emission rights were allocated. There was some justification for giving unconstrained emission rights to non-annex 1 countries as more than a billion people were living in poverty [World Bank's latest estimate (2008) shows 1.4 billion living with less than US$1.25 per day] and these countries needed to grow. However, non-annex 1 countries have grown at varied rates and the need to grow to deal with poverty is not pressing for some of them. How should their emission rights be fixed?

In any case, a cap and trade agreement in which emission quota is domestically auctioned is similar to a carbon tax. Carbon tax is simpler to administer [Nordhaus (2000), Shapiro (2009)] than cap and trade which would require setting up elaborate institutional arrangements for trade, certification and verification. On the other hand, short term price elasticity of emissions may be low and the reduction in emissions for a given tax rate may be lower than expected. Keohane (2009) has defended cap and trade. Essentially a cap and trade agreement determines the price of emission which is the same as carbon tax in the market while ensuring quantitative reduction. Such market determined price may show high volatility. Thus for example the EU-ETS price varied between Euro 9 and Euro 24 per tonne of CO2 over the period October 2008 to February 2009 (Nordhaus; 2009). A system of periodic revision of carbon tax depending on realised emissions reduction, say every 3 years, can provide an easier to implement and a stable regime.

In a system of carbon tax regime what is done with the tax revenue is critical. If the revenue is redistributed on some principle, it would imply some allocation of rights of emission quotas.

Even action by NACs under NAMA requires setting up a baseline for NAC emissions. This is also an allocation of emission rights.

A widely discussed notion of allocating emission quotas is that of contraction and convergence (Meyer, 1989, 2000) where eventually all will have the same per capita emission rights. How soon this equality is to be realised has profound implications for rights and obligations of countries. Thus allocation of emission rights (quotas) is implicit in almost all proposals and a critical element of any agreement.

Thus, allocation of emission quotas is unavoidable. It is also important to recognise that the scarce commodity is global atmospheric space that should be allocated.

It is important that this issue of allocation of emission quotas is addressed in a fair and just global compact. Global atmosphere is an open access common property, a parking space where countries park their emissions. It is not possible to fence the global environmental space to restrict emissions by any country. A common property resource can be maintained either by allocation of property rights or by common agreement cooperatively adhered to. An agreement would be adhered to only if it is perceived to be fair and just. It is, therefore, important to understand what would be a fair and just agreement. This is the question we address in this paper and suggest a just global impact.

5. Principles for a Fair and Just Allocation

An agreement acceptable to all must be based on fairness and justice. We look at the literature on the principles relevant to climate change negotiations.

5.1 *The Principles Embodied in UNFCCC*

The UNFCCC (United Nations Framework Convention on Climate Change) clearly acknowledges that "the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their *common but differentiated responsibilities and respective capabilities and their social and economic conditions* (emphasis added).

The "differentiated responsibilities" reflect different historical emissions and different levels of development of countries. 'Respective capabilities and their social and economic conditions' accepts that rich countries have to do more and the poor have a right to develop and the countries were divided into annex 1 and non-annex 1countries. It could be argued that this division was based on per capita emissions. For example, Belgium and the Netherlands, although small in size and population, are in annex 1, while China and India are not. One could say that consideration was given to poor countries due to their GDP level or standards of living, suggests that per capita emissions are implicit in the UNFCCC (Aldy, 2005).

The UNFCCC also clearly recognised the developing countries' right to development and that it will require increases in their emissions. Thus the non-annex 1 countries (NAC henceforth) were not required to restrict the growth of their emissions. To what level they were free to increase GHG emissions was not specified.

However, the world is not static. Obviously as ability and per capita emissions increase there should be a mechanism for countries to share responsibility.

5.2 *Accounting for Historical Emissions*

Should countries be responsible for their excess emissions that have led to the build up of GHG emissions in the atmosphere since the beginning of the industrial revolution? While it can be argued that historical emissions since 1890 should be counted for allocating responsibilities to countries, this may raise issue of moral responsibility. As Muller et al (2007) point out that according to Aristotle moral responsibility ('blame') can be limited because of ignorance. Recently, managing director of Brookings, Antholis (2009) has argued that "if developed nations are held responsible for emissions that they historically contributed, oblivious to their impact on climate change, why should not developing nations take responsibility for producing generations of people who will generate emissions in the future?" However, no country can claim ignorance of the impact of their emissions on climate change after 1990 when the negotiations for the UNFCCC started. Thus for arriving at a global consensus we consider that countries should be responsible at least for their emissions since 1990. To be symmetric, in any allocation based on population, the populations of all countries should be frozen at their 1990 levels.

5.3 *Rights to Global Environmental Space*

It is sometimes argued that "emission rights" should not be given to anyone as no one should have the right to emit. One can call it "emission quotas". Also, if the global community accepts that 450 or 550 PPMV is an acceptable level of GHG concentration, then the corresponding stock of GHGs is considered acceptable and that amount of atmospheric resource has to be allocated either as quotas or as rights.

Various principles have been advanced for allocating emission quotas. These include grandfathering, welfare impacts, costs and benefit incidence, emission efficiency of GDP and per capita basis. Comparison of welfare or costs and benefits across countries raise irresolvable difficulties of interpersonal comparison of utilities and index number construction; see Arrow K. 1951, 1963, and Rothschild and Stiglitz (1973). The economics profession does not have any answers to accounting for inequity across nations. One needs to realize this and rely on ethical principles and enunciate them explicitly.

A strong ethical case can be made for equal per capita allocation of rights to atmospheric resources. All democracies and all religions consider all persons equal. The U.S.A.'s declaration of independence considers "self-evident that all men are created equal".

Rothschild and Stiglitz (1973) show that such comparison holds for a one good economy. "If there is more than one good, the implications are substantial". This is of particular significance for international comparison.

Comparisons of interpersonal well-being across nations involve more than one element. The conventional approach of using purchasing power parity (PPP) adjusted GDP is also flawed on many counts.

First, GDP itself is now widely recognized as a poor indictor of well being (UNDP, 1990). This has inspired many attempts to create other measures of well-being or development such as the physical quality of life index (PQLI) by Morris M. (1979) and the various versions of the human development index (HDI) developed by UNDP. The HDI itself has been criticized for its theoretical inadequacy by many (Srinivasan T.N. 1994). The Index of Sustainable Economic Welfare (ISEW) calculations (Daly H.E. and Cob J.B., 1994) have shown that since 1970 ISEW has remained flat or declined even though GDP has continued to grow in the USA. Similar results have also been reported for England (Jackson and Marks, 1994).

Second, the real world of many commodities, services and attributes, poses the index number problem that raise difficulties which have no satisfactory answers.

Third, different societies, cultures, nations have different social structures, mores and public institutions. The public goods, services, social capital and safety nets provided are different. If a person dies, the loss suffered by the family is far greater than what her income may reflect. An emotional and financial safety net is gone for her family the loss of which would have very different impacts on the survivors in different societies.

Fourth, as Sen A.K. (1980) suggests, one should aim at equality of "capabilities" which are determined by a person's income, access to public good and services and social capital and institutions within which she functions. These clearly differ across societies and nations.

Fifth, the principle of "anonymity" used in welfare comparisons within a nation may not be acceptable internationally without a world government which gives the same rights to all human beings. For example, suppose that climate change interchanges the positions of US farmers and Indian farmers. This is not likely to be considered a `no welfare loss' situation by the US. The point is that one cannot be indifferent to who bears the impact.

While one may accept in principle that energy needed to meet certain basic needs can vary from person to person and place to place it would be a complex exercise to work out these needs. In any case equal per capita allocation would surely exceed emissions required to meet basic needs.

Box

Pitfalls of Cross Country Comparisons of Energy Efficiency

The relative prices and policies vary. The weights used for purchasing power parity adjustments are usually not appropriate for comparing energy use efficiency. For example, taxi rides from airport to downtown hotel in Mumbai and New York would be of similar length and would consume more or less the same amount of petrol. The value added by that ride in Mumbai will be $2 and in New York $20, whereas the PPP ratio would be around 4.0.

Source: *Parikh Kirit S. (2006)*

Should quotas to atmospheric resources be allocated on the basis of efficiency with which countries use energy? This efficient use argument is also false. In the neo-classical world of competitive free trade all producers use their resources efficiently. Energy, capital, labour,

materials, all can be substitutes in producing a product. If products sell at the same price, comparing intensity of one particular input makes little sense. Also comparisons of emission efficiency are fought with many pitfalls. Should we consider GHG emission per GDP? These depend on relative prices and the nature of economic organisation of a country. Even adjusting the GDP by using PPP exchange rate also does not solve the problem (see Box).

With tradable quotas to atmospheric resource global costs will be minimised. Equal per capita rights are fair because the burden of these costs will fall on those who are responsible for the threat of climate change and can afford them whereas benefits will accrue to the poor who need them. As Chancellor Angela Merkel observed at a Potsdam Conference "*if it involves large transfer from USA to India, what is wrong in it?*" The USA has an option to reduce the transfer by reducing its emissions. Not paying for emissions cannot be considered just. That such transfers may not be palatable to rich countries cannot be an argument against the justness of equal per capita allocations of global environmental space.

In general there is a wide consensus across countries (Manne and Richels, 1992; Baer et al, 2000; GCI, 2001) that eventually per capita emissions must be equal. The population for allotment of emission rights can be frozen on the day the global agreement is signed so as not to reward population growth and also to encourage early agreement. Also migrants may be allowed to carry their entitlement with them. Schellnhuber et al (2009) have advocated allocation on per capita basis as per 2010 population as the best solution from an ethical point of view.

6. Towards Just Global Compacts

While the Kyoto Protocol has stimulated some action in developing countries, the market for certified emission reductions (CERs) is thin and so the price received is also low. Thus the net effect on global emissions is marginal. If the A1Cs accept deep cuts, then CDM can be more effective.

Another expectation from CDM was technology transfer. As per a CDM board report (Seres Stephen, 2007) only 39% of the CDM projects involved technology transfer of which 67% include transfer of knowledge.

A new more effective global compact is needed as there is growing global concern about climate change. The growing emissions of some large NACs is causing concern and is being used as an excuse by some A1Cs to delay action on mitigation. How should we proceed? We suggest below an alternative which is consistent with the UNFCCC principle of common but differentiated responsibility.

6.1 *Rental for Parking Emissions in the Global Environmental Space*

Considering that global atmosphere is like a parking space for GHG emissions, we propose that rent should be charged annually from all countries for every tonne of atmospheric space occupied by their accumulated GHG emissions. For this purpose all emissions from 1990 onwards should be chargeable, since by 1990 all counties knew that climate change is a possibility. Rent is like a carbon tax that is levied on a country's cumulative emissions from a given date. It will encourage countries to delay occupying the permissible atmospheric GHG holding space. Rent by itself is independent of allocation of rights, which

come into play when we distribute the proceeds from the rent. The rent collected should be distributed on some principle of justice, which we suggest to be equal distribution on a per capita basis to all nations of the world based on their 1990 population.

The proposal has a number of advantages.

- Charging rent for the stock of accumulated emissions is rational as it is the stock of GHGs that causes climate change/global warming.
- All countries are involved and no distinction between annex 1 and non-annex 1 is needed.
- It will provide appropriate incentives to all countries to be carbon efficient as they all face the same opportunity cost of emissions.
- It also rewards countries for their negative emissions, which play a very important role in many long term global scenarios. For example Riahi et al (2007) show considerable negative emissions from carbon capture and sequestration, bio fuels and afforestation to reach and maintain GHG concentration of 520 PPM.
- It provides a simple mechanism to transfer resources across countries with very little transaction cost and minimal bureaucracy.
- By increasing the rental rate with a cess, compensation for adaptation can also be factored in. The cess collection can be distributed to countries as per their population and in inverse proportion to their per capita emissions with a minimum amount given to all countries with small populations.

This to us is a just compact consistent with UNFCCC where all participate as per their common but differentiated responsibility and capacity.

Table 4
GHG Emissions in Billion Tonnes of CO_2 equivalent/yr SRES B1_520 Scenario

Regions	2000	2010	2020	2030	2040	2050
GLOBE	40.12	41.22	45.72	45.15	41.33	33.46
ASIA	11.47	12.11	14.40	14.41	13.30	11.48
LAFM	9.29	9.97	12.13	13.86	14.26	11.88
OECD	15.02	15.04	14.97	12.59	9.38	6.37
REFS	4.34	4.10	4.23	4.29	4.39	3.74
CPA	5.71	6.57	8.25	8.40	7.57	6.32
PAS	3.23	3.18	3.74	3.63	3.07	2.06
SAS	2.54	2.36	2.40	2.38	2.66	3.09
AFR	2.64	2.70	2.97	3.17	3.33	3.51
EEU	1.05	0.97	0.91	0.77	0.60	0.41
FSU	3.30	3.13	3.32	3.52	3.79	3.32
LAM	4.59	4.85	5.91	6.24	5.78	4.27
MEA	2.06	2.42	3.25	4.45	5.15	4.10
NAM	7.98	8.12	8.49	7.34	5.81	4.11
PAO	1.98	1.93	1.72	1.32	0.75	0.35
WEU	5.06	4.98	4.75	3.93	2.82	1.90

Note:

ASIA:	South Asia, Pacific Asia, Central Asia and China (SAS, PAS, CPA)	LAFM:	Region of Latin American and African Countries (AFR, LAM, MEA)
OECD:	Western Europe, North America, Pacific OECD (WEU, NAM, PAO)	REFS:	Region of Countries Undergoing Economic Reform (EEU, FSU)
AFR:	Sub-Saharan Africa (AFR)	CPA:	Centrally Planned Asia and China (CPA)
PAS:	Other Pacific Asia	SAS:	South Asia
EEU:	Central and Eastern Europe	FSU:	Newly Independent States of the Former Soviet Union
LAM:	Latin America and the Caribbean	MEA:	Middle East and North Africa
NAM:	North America	PAO:	Pacific OECD
WEU:	Western Europe		

Source: Updated SRES scenario results provided by IIASA.

To illustrate what this scheme involves, we consider SRES scenario B1-520, which stabilises GHG concentration to 520 PPMV. The scenario provides emissions from 2000 upto 2100 by 10 year intervals for 11 regions of the world which are further aggravated into 4 regions, Asia; Latin America, Africa and Middle East Asia (LAFM); OECD and Region of Countries undergoing Economic Transition and Former Soviet Union (REFS). For ease of presentation we consider emissions upto 2050 only. Two types of regional breakups are given, 4 large regions and 11 smaller constituents of the regions. Numbers for each break up add up to the global total.

Table 4 gives projected GHG emissions including land use change up to 2050 for the 520 PPM scenario..

It is worth noting here that Asia's emissions exceed OECD's emissions only in 2030, even though Asia's population was 2804 million in 1990 compared to OECD's population of 857 million.

Cumulative GHG emissions from 1990 till 2000 are calculated from data on yearly GHG emissions of 1990 and 2000 obtained from World Resources Institute's website (WRI 2009) and are shown in *Table 5*.

Table 5: Cumulative GHG emissions 1990-2000

Region	Bt CO2% of Global	1990 Population Millions
GLOBE	430.2	100.0	5246
ASIA	128.6	29.9	2804
LAFM	102.7	23.9	1190
OECD	142.6	33.1	857
REFS	54.9	12.8	396
CPA	50.7	11.8	1251
PAS	53.1	12.3	388
SAS	20.1	4.7	1116
AFR	27.1	6.3	482
EEU	11.7	2.7	112
FSU	43.1	10.0	284
LAM	58.2	13.5	438
MEA	17.3	4.0	276
NAM	73.8	17.2	278
PAO	24.1	5.6	187
WEU	49.1	11.4	435

Table 6 gives gross cumulative emissions. These are obtained by interpolating yearly emissions between the years given in *Table 4,* cumulating them and adding the 1990-2000 emissions of *Table 5*.

Table 6
Gross Cumulative Emissions Since 1990 (Billion Tonnes of CO_2)

	2000	2010	2020	2030	2040	2050
GLOBE	430	837	1274	1728	2158	2527
ASIA	129	247	380	524	662	785
LAFM	103	199	311	441	582	711
OECD	143	293	443	579	687	763
REFS	55	97	139	181	225	265
CPA	51	77	106	137	169	204
PAS	53	115	189	273	352	421
SAS	20	30	39	48	55	60
AFR	27	59	92	126	162	198
EEU	12	59	113	174	234	283
FSU	43	66	94	133	181	227
LAM	58	139	222	301	365	414
MEA	17	37	55	70	80	85
NAM	74	106	141	177	211	235
PAO	24	48	72	96	121	150
WEU	49	99	148	191	224	246

In terms of cumulative emissions ASIA exceeds OECD only in 2050. SAS, South Asian region, with a population of 1116 million in 1990, remains the lowest cumulative emitter, even lower than EEU, the region with the lowest population of 112 million persons in 1990.

In principle , in order to work out how much global space is occupied in a country, we need to subtract the share of per capita absorptive capacity from each country's emission for each year. Absorptive capacity varies depending on many factors. Would the seas saturate with CO2? How would temperature change, wind velocity etc affect CO2 absorption? Only one thing is

somewhat certain that the absorptive capacity will change. Though in principle, a knowledge of global GHG concentrations and annual global emissions one can ex post work out what must have been absorbed. Even here, it will not be possible to differentiate what has been absorbed by national resources and what by global commons. Thus while ideally, rent should be charged on the basis of net accumulated emissions, we will use gross accumulated emissions for illustrating our proposal. **We emphasise however, that as long as the global environmental space and the global absorptive capacity are distributed across countries in the same proportions, the net transfer of resources would remain the same.**

With an annual rental of R US dollars pre tonne of CO_2 a country has to pay R times the gross cumulative emission of *Table 6*. With redistribution of the aggregate rental on a per capita basis, the net payment a region has to make is given by its payment less the share of the population of year 2000 of the region in the total global rent collection. Thus,

Net payment of region *i*	=R	x	Net cumulative emissions of region *i*
	- R	x	Total net cumulative emissions of all countries
	x		(Population of region *i*/global population)

What should be the annual rental rate? If the price of CO_2 emission traded today is P and if the emissions stay in the atmosphere for *n* years and if the discount rate is *i*, then the annual rental *R* should be as follows:

$$P = R\left(\frac{1+i-\frac{1}{(1+i)^n}}{i}\right)$$

With a low discount rate of 1 percent and 100 years CO_2 life time

$$i = 0.01$$

and $$n = 100$$

we get $P \simeq R\,(100)$

With CO_2 trading at \$20 per tonne, P = 20 and R = P/100 $\simeq$ 0..20 \$/tonne/year.

With an annual rental R of \$0.20, the net payments payable by each region is shown in *Table 7* and plotted in *Figures 3* and *4*.

Table 7
Net Rent Payable @ US$ 0.2/Tonne of CO_2 (Billion US$)

	2000	2010	2020	2030	2040	2050
GLOBE	0.0	0.0	0.0	0.0	0.0	0.0
ASIA	-20.0	-39.6	-59.3	-78.7	-96.8	-111.4
LAFM	1.0	1.8	4.2	9.7	18.3	27.4
OECD	14.2	30.7	46.2	58.3	65.5	68.5
REFS	4.5	6.8	8.5	10.2	12.4	14.9
CPA	-10.4	-24.5	-39.6	-55.1	-69.1	-79.8
PAS	4.3	10.6	19.1	29.0	38.5	46.8
SAS	-14.3	-29.6	-46.3	-63.9	-80.9	-95.6
AFR	-2.5	-3.5	-5.1	-6.6	-7.2	-6.9
EEU	0.5	8.2	17.2	27.4	37.6	45.8
FSU	4.0	4.1	5.0	7.9	12.9	18.0
LAM	4.5	13.8	23.1	31.2	37.0	40.5
MEA	-1.1	-1.4	-2.4	-4.2	-6.8	-9.6
NAM	10.2	12.3	14.6	17.2	19.3	20.3
PAO	1.7	3.7	5.4	6.9	8.9	12.1
WEU	2.7	6.0	8.4	9.4	8.9	7.3

Note: Rent is assumed to remain constant through the period

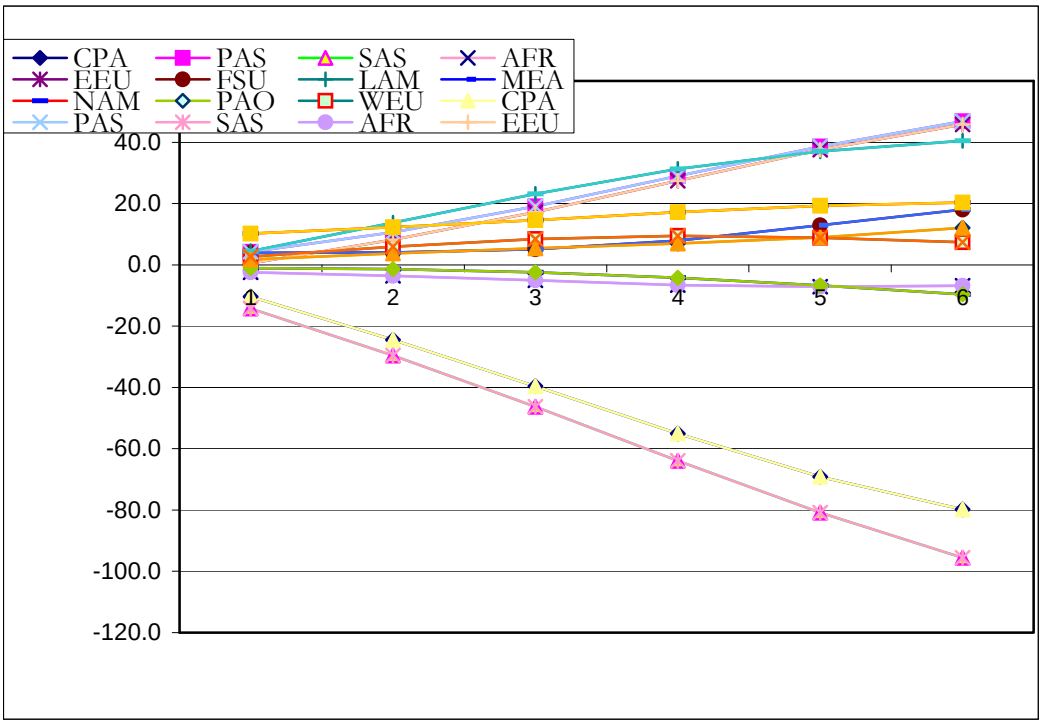


Figure 3 : Net Rent in Billion US at $0.2 per Tonne of CO_2

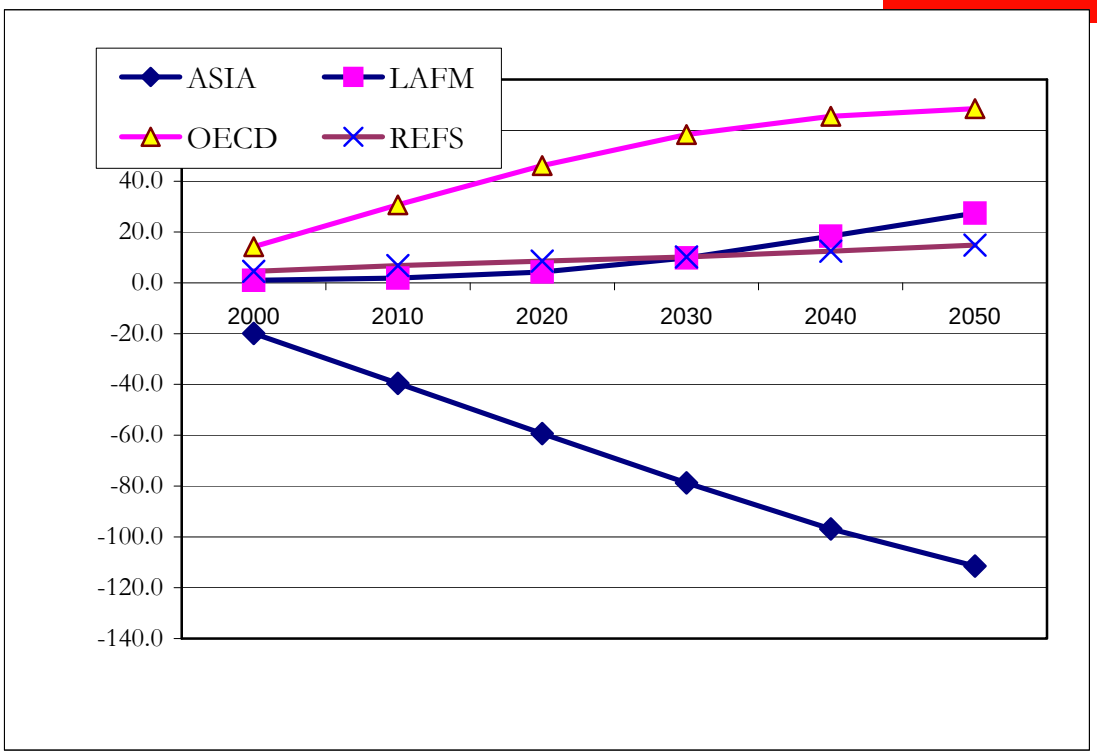


Figure 4 : Net Rent Payable for Stock of CO_2 - Billion $ Per Year at $0.2 Per Tonne

It is seen that rental payable by OECD countries increases from $13 billion in 2000 to $66 billion by 2050.

The SAS region which includes India is entitled to receive a net payment of $8.9 billion in 2000 which increases to 67 billion in 2050. Even CPA region, which includes China, gets $4 billion in 2000 which increases to $19 billion by 2050. These results show the extent of the occupation of the global environmental parking space by OECD and REFS countries at the cost of countries of Asia and Africa.

6.2 Carbon Tax

If the collection of rents over a long period of time is considered impractical a carbon tax of $20/tonne can be considered as the present discounted value of annual rentals. It can be levied on annual emissions and not accumulated emissions. Again if a carbon tax is imposed from 2010 onwards and proceeds distributed equally as per 2010 population, the projected transfers are shown in Table 5. The transfers are much more than those required under the annual rental scheme and decrease over time as they are front-loaded. It may be noted that everybody pays the tax, which is distributed equally on per capita basis as per 2010 population, the date of the initiation of carbon tax regime. There is here no historical responsibility.

Table 8: NET Payments with Carbon tax at US$20 per Tonne of CO2 equivalent Distributed equally on per capita basis with 2010 population(Billion in US$)

	2010	2020	2030	2040	2050
GLOBE	824.32	914.49	902.95	826.52	669.22
ASIA	-191.05	-192.73	-186.34	-168.45	-122.14
LAFM	-25.07	-6.38	31.28	60.26	55.31
OECD	185.21	171.20	125.34	71.68	33.55
REFS	30.91	27.91	29.73	36.52	33.28
CPA	-44.89	-30.52	-25.13	-25.37	-16.67
PAS	-3.76	0.11	-1.14	-6.11	-13.44
SAS	-142.41	-162.32	-160.08	-136.97	-92.03
AFR	-45.60	-51.08	-45.81	-33.24	-10.72
EEU	4.51	1.61	-0.97	-2.94	-3.85
FSU	26.40	26.30	30.70	39.45	37.13
LAM	26.32	39.83	47.32	44.71	28.04
MEA	-5.79	4.87	29.77	48.79	38.00
NAM	122.17	125.23	102.80	75.81	49.54
PAO	19.97	13.69	5.84	-3.81	-8.11
WEU	43.07	32.27	16.70	-0.32	-7.88

6.3 Implementation Strategy

Of course the SRES scenario has built in emission constraints to stabilise GHG concentration at 520 PPMV. Without these constraints countries would have emitted much more. It is not clear if \$20/tonne of CO_2 is an adequate price for countries to follow the emission trajectory of the scenario. The price of CO2 will have to be adjusted and the rental rate correspondingly fixed to see that the global emissions follow the trajectory of the agreed scenario, 520 PPMV in this case. A mechanism for updating rental rate should be decided at the time of the global agreement.

Alternatively, an acceptable stabilisation level of PPMV should be agreed on. This will determine the trajectory of GHGs in the global atmosphere i.e. the total available parking space. This may be allocated to all countries on equal per capita basis. The countries should be free to trade the space. Such a system of allocation of global environmental parking space and trading of it can force the countries to follow the trajectory. Implementation will be no more difficult than that of any cap and trade of emissions scheme. The same mechanism that can enforce a cap and trade agreement can enforce this cap and trade of global carbon space.

If a global agreement is obtained that stabilisation should be at 520 PPMV than the global emission trajectory and the corresponding CO_2 content (row 1 in *Table 6*) in the atmosphere gets fixed. This defines the available atmospheric resource which can be allocated to all countries on equal per capita basis, which they can trade every year. There would be no need to fix any rental price from outside as the market would determine this.

How the entitlements to global carbon space are distributed within the country should be left to the country governments. Country governments may impose a tax or auction the entitlements. In addition a country government may also take other measures such as mandating efficiency standards, to meet its obligations.

As noted earlier a system of periodically adjusted rental rate to track a desired trajectory of global emissions, distributed equally to all is easier to implement than a cap and trade system.

6.4 Responsibility for Adaptation

Even equal per capita allocation of global environmental space does not take care of the adaptation burden imposed on people. One should also note that allocation of atmospheric space does not absolve the allottee from the responsibility to compensate those on whom adaptation burden is imposed. Anyone who contributes to the threat of climate change should pay for the adaptation burden imposed on others. A country's liability should be based on the global environmental space occupied by it and for how long it has been occupied by it.

Many developing countries and India in particular, are vulnerable to impacts of climate change. And whether they like it or not will have to adapt to it and bear the burden of adaptation as well as impacts to which no adaptation is possible. This is a burden imposed on them by the cumulated emissions of industrialised countries and must be compensated for. To compensate developing countries for adaptation, a fund was created at Bali Conference. Not only, it is meagre, but it is funded by a cess on CDM transactions of CERs, which is a tax on the developing counties as EU-ETS is outside it.

It would be difficult to assess the additional cost due to adaptation. Also to estimate it a huge bureaucracy may be needed. A much simpler way is to put a cess on carbon emissions and better still, on cumulative carbon emissions and redistribute this to countries on per capita basis in inverse proportion to their per capita GHG emissions. If some small countries with very small population do not get adequate resources with equal per capita allocation a certain minimum amount may be given to countries with small populations.

6.5 Adaptation: The Forgotten Responsibilities

India is vulnerable to impacts of climate change. And whether it likes it or not will have to adapt to it and bear the burden of adaptation as well as impacts to which no adaptation is possible. This is a burden imposed on India by the cumulated emissions of industrialized countries and must be compensated for.

The Fourth Assessment Report of the IPCC (2007) has concluded that the warming of the earth's climate system is unequivocal. In fact, a number of studies have observed (GOI, 2008) changes in climate parameters in India (Government of India, 2004). A national level increase of around 0.4°C has been observed in surface temperature over the past century. Trends of increasing monsoon rainfall has been observed in some parts of India and decreasing trend in some others. Changes in frequency of extreme events have been

observed (Goswami et al, 2006). Based on 40 years of data Unnikrishnan and Shankar (2007) have estimated sea level rise of 106-175 mm per year. Himalayan glaciers are observed to be receding.

The impact of projected climate change on India is estimated to be multifaceted and serious. GOI (2004) has projected decline in total run-off for all river basins, except Narmada and Tapti.

Rosenzweig and Parry (1994) have estimated significant adverse impact on the agriculture of many developing countries. In a more detailed study of India, Kumar and Parikh (1997 and 1998) examined the impact on agricultural yields, output, income and prices. They estimated that: (a) yield losses (without considering the carbon fertilization effect) for rice vary between 15 to 42 percent and for wheat between 25 to 55 percent for temperature increases of 2.5°C to 4.9°C; GDP would drop by between 1.8 to 3.4 percent and agricultural relative to non-agricultural prices would increase by 7 to 18 percent; (b) even with carbon fertilization effects, losses would be in the same direction but somewhat smaller; (c) with adaptation by farmers of cropping patterns and inputs, losses would remain significant; with a temperature change of +2°C and an accompanying precipitation change of +7 percent, farm level total net-revenue would fall by 9 percent, whereas with a temperature increase of +3.5°C and precipitation change of +15 percent, the fall in farm level total net-revenue would be nearly 25 percent. For developing countries, these are very large changes which can cause much human misery. From India's point of view, a 2°C increase would be clearly intolerable. Other developing countries may be even more vulnerable.

Increased occurrence of extreme events due to climate change such as floods, cyclones, droughts, etc. will also affect the poor most. In the cyclone in Andhra Pradesh in India in 1996, more than 1,000 people died and there was huge property loss. Cyclones of similar intensity in advanced countries like the U.S., may not lead to any deaths, if at all.

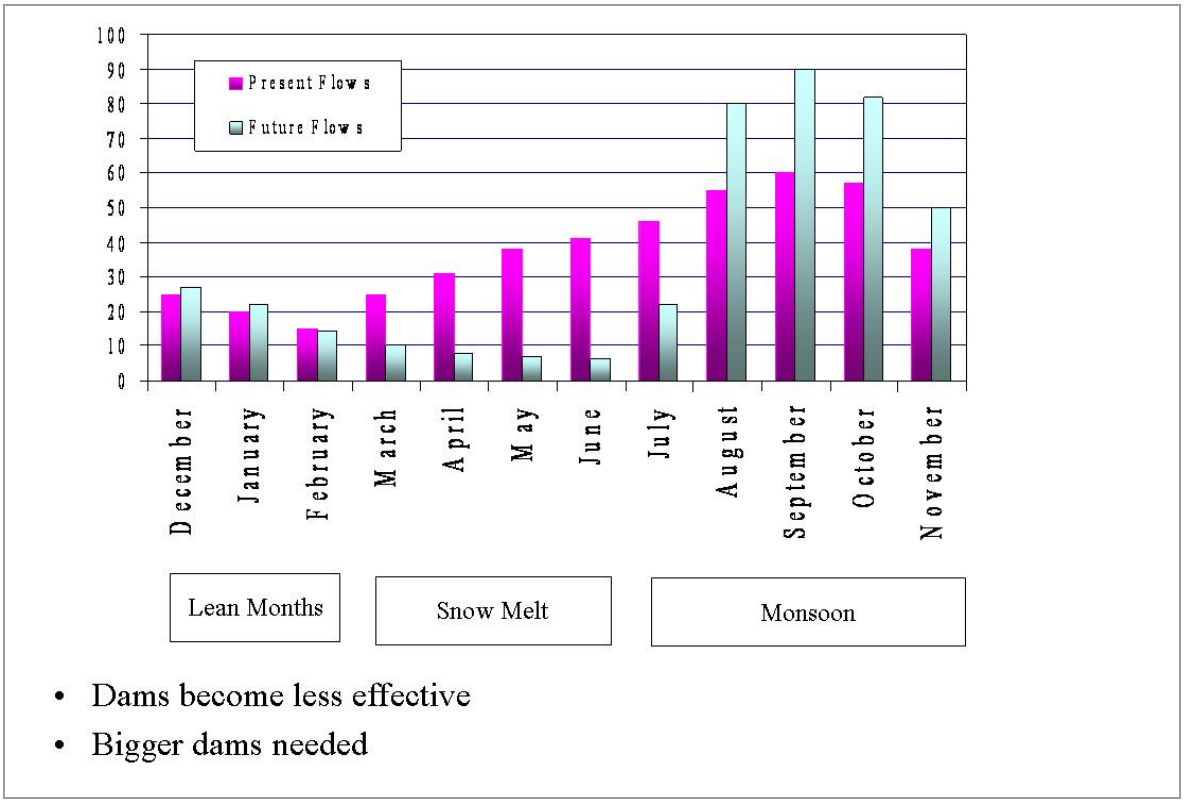
A mean sea level rise of 15-38 cm is projected along India's coast by middle of the century and 46-59 cm by 2100 (GOI, 2008). Large-scale out-migration from coastal zones is expected due to sea level rise. Furthermore, intrusion of sea-water in the ground water and changes in temperature can reduce agricultural incomes. This will create a large number of environmental refugees especially from low-lying delta regions in poor countries. Countries dependent on agricultural production, which most often include developing countries, are likely to be adversely affected.

A. 1 metre rise will lead to land loss of 0.6 million hectares of land, submerge 0.75 million houses, 4000 km. of road length and other coastal infrastructure, and displace more

than 7 million persons in India. This is a 10 year old estimate and losses today would be much more. Also one third of Bangladesh will be submerged displacing 30 to 40 million persons many of whom are likely to spill over into India.

The change in hydrological regime can make many of our irrigation infrastructure less effective. *Figure 5* shows a possible change in flows of Himalaya rivers due to climate change. To adapt to it is to build bigger dams with much larger financial and sociological costs.

Figure 5: *Himalayan Rivers (Hypothetical)*



Climate change is also expected to increase the incidence of vector- borne diseases such as malaria. Climate change will also change forest types in most of India's Forests (Ravindranath et al, 2006) which will affect the livelihoods of many forest dependent people. To compensate developing countries for adaptation bunder, a fund has been created. However, it is meagre at present.

It would be difficult to assess the additional cost due to adaptation. Also to estimate it a huge bureaucracy may be needed. A much simpler way is to put a cess on carbon emissions and better still on cumulative carbon emissions and redistribute this to countries

on per capita basis in inverse proportion to their per capita income and per capita GHG emissions.

7. Conclusions

We have argued that a just global compact would allocate the global environments absorptive capacity and the global atmospheres holding space corresponding to any agreed level of stabilisation, on equal per capita basis. Then either the countries can trade this entitlements on an annual basis or a rental may be charged the receipts from which are distributed equally to all citizens of the earth. A part of the rent collected could be given to small countries on a per country basis. A part can also be set aside for emergency assistance.

This is also a cap and trade scheme or a carbon tax scheme and no more or less difficult to implement it. Only the entitlements are fixed on equal per capita basis. The scheme provides a simple mechanism to transfer resources based on rights and not as charity.

It may be emphasised that while we have used the B1-520 scenario for illustration, implementation of the scheme does not require any agreement on the scenario to be used as a benchmark scenario. Of course a desired trajectory of global emissions has to be agreed upon if the rental or tax is to be adjusted periodically.

The way forward should include in addition the following actions:

A. Mitigation:

(a) Industrialized countries should stop passing the buck to the developing countries without fulfilling their pledge of leading the efforts for GHG reduction according to differentiated responsibilities. They need to take on deep cuts immediately to reach the goal of 50% by 2030 and 80% in 2050. .

(b) A system of criteria is also needed for engaging the developing countries. Picking on India or lumping it with China has to stop.

B. Financing Adaptation:

(a) New frameworks and financing modalities are needed for sharing burden for risks, impact, vulnerability and adaptation. The liability framework of polluters-pay is conveniently ignored by resorting to ad hoc aid and even worse using meagre adaptation funds deducted from carbon credits earned by developing countries.

(b) Increased aid channelled through bilateral co-operation or multilateral organization must be provided. While an adaptation fund has been created and some aid is provided for mitigation, these need to be substantially strengthened with some new initiatives. These are at a very small scale.

(c) Institute liability framework based on polluter pays principle.

(d) Set up a global insurance fund for extreme events.

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