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Confronting the Climate Change Challenge: Discussing the Role of Rural India under Cumulative Emission Budget Approach

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Abstract

Current global climate policy architecture does not aim at stabilizing the greenhouse gases concentration in atmosphere that may achieve the proclaimed 2°C guard rail. An alternative approach that targets on limiting the global cumulative emission to accomplish such an outcome is put forward by German Advisory Board of Global Change (WBGU). This research work further elaborates the approach and its flexibility instrument i.e. carbon trading. As the approach visualises sharing of the carbon budget (750Gt CO2) equally to every human being (2.7t CO2 per capita), India is the country with largest tradable surplus reflecting its low emission per capita and large population. The research work further analyzes the emission profile of rural India and the significance of its future emission pathways with in the proposed framework. It also shows how low carbon development in India can assist in cost effective decarbonisation of industrialised countries and mitigation of climate change, given a global climate treaty based on the WBGU approach.

1. Introduction

Without significant change in the current emission path of green house gases (GHGs) (reflected in atmospheric CO2 concentration of 270 μmol mol−1 during pre-industrial times, 387 μmol mol−1 in 2009, possibly 550 μmol mol−1 by 2050 and 800 μmol mol−1 by 2100 [Long and Ort 2010]), the world appears set on a path of rising global temperatures up to 6°C, with catastrophic consequences for the environment. Even with temperature escalations considerably below 6°C, there could be profound negative ramifications on food production, natural ecosystems, freshwater supply and health care. Climate change (CC) can also trigger large scale migrations (IOM 2008) as its implications could be beyond the resilience and adaptation capacity limits of many communities and states. It could also increase security risks and exacerbate conflicts over the existing resources. Given the scientific consensus on anthropogenic origin of climate change (Rosenzweig et al. 2008; Doran and Zimmerman 2009; Anderegg et al. 2010), it is our common future responsibility to effectively address the challenge of climate change through reducing greenhouse gases (GHG) emissions and fostering adaptation. It requires global cooperation on a unprecedented scale and significant changes in the current policy frameworks. Unfortunately time frame for avoiding potentially dangerous consequences is closing.

Reiterated in Copenhagen accord (COP 15 of UNFCC), climate experts and the world's political leaders agreed on the goal of limiting the rise in global average surface temperature by 2°C (UNFCC 2009). The decision of the 2°C as a tolerable limit partly reflects the IPCC assessment on possible impacts of a range of warming scenarios (2-4 degrees) and expected temperature escalation given a mid-range emissions trajectory until the end of the current century (New et al. 2011). Still the present policy instruments [Kyoto protocol along with its flexibility instruments such as clean development mechanism (Article 12), joint implementation (Article 6) and emission trading (Article 17)] do not aim at robust measures that may stabilize the atmospheric concentration of carbon dioxide and other GHGs (UNFCC mandate) that may achieve the proclaimed 2°C guard rail. The status-quo regime is based on short term commitments on emission reduction by individual nations instead of a binding long term global target on aggregate emissions combined with a burden sharing arrangement (Wicke et al. 2010).

The Kyoto protocol could oblige emission reduction commitments from developed countries that are responsible for 29% (in 2006) of the global emissions (Miyagawa 2009) and is clearly inadequate for achieving sizable impacts on reducing the accumulation of greenhouse gases in the atmosphere. In addition, enforcement of the treaty is weak reflected in the non-compliance of Kyoto targets by many countries (Barret 2008). In contrast (Article 4.2 (a) and (b) of UNFCC), developing countries are not mandated to curtail their emissions. Such a differentiated responsibility is justified according to the "polluter pays" principle (Tol 2006) as developing countries are responsible for a relatively small amount of historic greenhouse gas (GHG) emissions (eg: India accounts 2% of the cumulative emissions during the period between 1900-2007 [IEA 2007]). Nevertheless, considering the skewed distribution of CC impacts (Tol et al. 2004; Lieshout et al. 2004; Buys et al. 2007; Lobell et al. 2008; Schlenker and Lobell 2010), higher vulnerability due to the natural resource dependence (Adger et al. 2003; Sathaye et al. 2006; Allison et al. 2009), less adaptive capacity (Tol et al. 2004; Metz et al. 2009; Thornton et al. 2011) and their growing share of current global GHG emissions, proactive engagement of developing countries in domestic and international efforts for mitigation and adaptation is inevitable.

In this context, the discussion of a meaningful future global climate policy architecture that can balance the aims of developing and developed countries and achieve the climatic goal is appropriate. We consider the WBGU as a promising approach in this direction and aim to elaborate it and explain why future emission trajectory of rural India is a deciding factor under this framework.

2. WBGU budget approach to address the climate dilemma

Given the scientific evidence that the warming effect of green house gases, especially CO2, is insensitive to the timing of their emissions but only to the aggregate emissions, realistic policy instruments have to address their cumulative emissions instead of emission rates or concentration targets (Bowerman et al. 2011; Allen et al. 2009; Mathews et al. 2009). The budget approach formulated by the German Advisory Board of Global Change (WBGU) is based on cumulative emissions of green house gases and hence is scientifically robust. According to Meinshausen et al. (2009), global CO2 emissions not exceeding 1160Gt CO2 from anthropogenic sources between 2000 and 2050 provide a 67% probability to meet the 2°C target. As 350Gt CO2 have already been emitted from anthropogenic sources between 2000 and 2009 and emissions of 60Gt CO2 are expected from land use changes between 2010 and 2050, a stock of about 750Gt CO2 remains. Sharing this budget among the nations on a per capita basis and allowing the nations to trade the non-utilized shares are considered as central instruments of WBGU budget approach.

2.1 The characteristics of budget approach

A number of characteristics differentiates the budget approach from other policy architectures addressing the global climate change such as Kyoto protocol, carbon taxes, carbon trading proposals, technology development and transfer schemes, global climate Marshall plans etc. (Aldy et al. 2003) WBGU approach predefines the environmental goal (2°C guard rail) as well as the corresponding global cumulative carbon budget (given the scientific understanding of the phenomenon) and presents the cost effective way to limit the cumulative emissions to the predefined budget. The major characteristics of the approach are

1. Following the 2°C target: The approach aims at limiting the warming to 2°C. Macintosh (2010) analyzed the cumulative emission trajectories, given the current path of international climate negotiations and found that meeting the 2°C guard rail requires more than 5% (possibly more than 10%) reduction of emissions per year after 2030, which is apparently less likely. The scenario of having no comprehensive global cumulative emission reduction commitments increases the likelihood of warming more than 4°C within the 21st century. The consequences of climatic changes of that scale may be much higher than containing the temperature escalation with in the 2°C guard rail, especially in the developing world (Bowerman et al. 2011).

2. Focusing on CO2: The WBGU‘s proposal focuses on the cumulative emission of carbon dioxide from anthropogenic sources as global warming can be largely attributed to its atmospheric concentration (Solomon et al. 2008). Due to the persistence of CO2 in the atmosphere, WBGU argues for targeting the global deal on CO2 alone, and handling other greenhouse gases through separate regulations. Unlike the CO2, the

warming effect of other greenhouse gases (eg: methane) can not be attributed to their historical emissions but rather to very recent emissions and hence their emissions can be managed by targeted regulations and technological changes instead of a global trading scheme. Global methane initiative can be an example (www.globalmethane.org/).

3. Defining a global cumulative carbon budget: Instead of fixing individual country targets, a common aggregate emission budget is proposed. The existing scientific evidence shows that an aggregate global emission of 750Gt CO2 between 2000 and 2050, meets the 2°C target with 67% probability while 600Gt CO2 holds a 75% probability. It is subject to political decisions in terms of choosing a certain probability and a related carbon budget in relation to international consensus building.

4. Legal basis: The proposal emphasizes on compliance and the agreement has to be legally binding.

5. Allocating national emission allowances on per capita basis: WBGU argues also for per capita distribution of the carbon budget and universal participation of all nations. For the period 2010-2050, an average annual emission allowance of 2.7t per capita of the world population is calculated to meet the 2°C guard rail. Universal participation and convergence to per capita emission permits can potentially provide incentives for effective and efficient control of global emissions and to ensure participation of developing countries (Berk and Elzen 2001). From an ethical point of view, the principle of equal rights is the fundamental rule for global commons and other ways of sharing tends to institutionalize inequity (Baer et al. 2000). Per capita approach can also be justified based on the concept of historical responsibility (Bode 2004). Nevertheless Posner and Sunstein (2008) argues against the per capita approach on the grounds of inequitable distribution of costs and benefits among developing and developed nations but in our opinion, such a redistribution could be justified considering the historic emissions by the developed world and disproportionate damage costs on developing countries. Bauemert et al. (2005) also argues similarly to Posner and Sunstein (2008) but also admit that virtually any national and international climate policy will result in promoting the convergence of per capita emissions and convergence is akin to climate protection as the net emissions in the longer term has to fall to zero.

6. Carbon trade: Given the fact that the current per capita emissions in industrialized countries largely exceed the per capita allowance (2.7t CO2 per year), the purchase of emission rights from nations having surplus budgets could allow their cost effective transition to decarbonisation of the economy. On the other hand, the selling of the rights can finance the transition of the recipient nations towards a low carbon growth and accelerate adaptation efforts. In contrast to existing transfer payments for adaptation and mitigation (similar to adaptation fund), 1) substantial funds can be generated by trade of permits. In the case of adaptation fund for developing country signatories of Kyoto protocol, the funding is limited to 2 percent of share of proceeds on certified emission reductions under the CDM activity (UNFCC 2011) and clearly inadequate to meet the requirements 2) in contrast to many existing trading arrangements based on grandfathering of pollution permits that tends to benefit the heavy polluters (Woerdman 2009), the least polluters are rewarded under the WBGU approach 3) the idea of global emission trade based on per capita emission also differs from the North/South transfers within the framework of economic cooperation or development aid which follows a helping-hand approach or attitude. Given the merits, budget approach presents strong incentives for developing countries to accept the emission limit unlike the existing climate policy architecture.

7. A world climate bank: It is proposed to supervise national emission budgets and decarbonization roadmaps and enabling the flexibility mechanism i.e. carbon trade.

8. Additional measures: Emissions of green house gases other than CO2 are to be treated in separate regulations. Further climate partnerships as JI and CDM or Reduction of Emissions from Deforestation and Degradation (REDD) are to be implemented.

2.2 Emission pathways of different countries

Depending on the current per capita emissions of each country, three broad categories of emission pathways can be proposed, given a treaty based on the budget approach.

Path 1: Comprehensive Decarbonization before 2050 (for countries emitting above 5.4t/capita CO2)

Mainly industrialized economies have to follow this path (e.g. EU 8.1t, Japan 9.7t, USA 19.3t) along with oil-exporting countries (e.g. United Arab Emirates 28.3t, Kuwait 33.3t) and a small number of newly-industrializing countries (e.g. South Africa 8.9t, South Korea 9.7t). These nations emit far more than the emission limit of 2.7t CO2 per capita and are expected to exceed national share of the cumulative global emissions budget in less than 20 years. They have to move towards rapid and comprehensive decarbonisation process. However, during the transition period, they can depend on carbon trade with other countries that are having surplus budgets.

Path 2: Stabilization of Emissions and Transition to decarbonization (for countries emitting between 2.7 and 5.4t/capita CO2)

Many newly-industrializing countries (e.g. Thailand 4.1t, Mexico 4.2t, China 4.3t), can pursue this path. As dramatic emission reductions are generally not feasible, these countries would have to show a gradually declining rate of emission growth that peaks in 2025 followed by a decarbonisation path to 2050.

Path 3: Avoided carbonization and surplus trade (for countries emitting below 2.7t/capita CO2)

A third emission path can be taken by developing countries (e.g. Burkina Faso 0.1t, Nicaragua 0.7t, Vietnam 1.2t), and some large newly industrializing countries (e.g. India 1.2t and Brazil 1.9t). These countries account for about 12% of current global CO2 emissions; but they are home to more than half of the world's population by 2010 and the global emission budget. While countries on path 1 and 2 can utilize surplus rights of this group during the transition stage so that they can reduce their emissions at a relatively slower rate. In the case of nations with surplus budget, avoiding carbonisation and keeping the per capita emissions below 2.7t CO2 represents an economic opportunity. The trade of rights are supposed to generate sufficient funds to be invested in low-emission technologies, especially the energy sector. It is essential that these countries follow the path of avoiding carbonisation and hence not fully exploit their emission budgets for successful execution of the WBGU approach.

2.3 Role of India in the WBGU approach

India's aggregate emissions were around 1.5Gt CO2 in 2008, which is 1.7Gt CO2 below its budget share of 3.2Gt CO2. It means the country could sell the surplus CO2 emission allowances under the WBGU framework and still meet its emission limit. As a country with the largest surplus budget under WBGU approach, we further discuss India's role in the framework.

3. India's emission profile

Starting with a background note on national policy, we would like to show how the current emission status is attributed to the different sectors of the Indian economy and different sections of the Indian society and what kind of emission scenarios are expected for them in the near future.

3.1 National climate policy

India is a signatory of UNFCC and Kyoto protocol. In its submission to UNFCC (COP 13) on the long term cooperative action, India has stressed its commitment to stabilisation of atmospheric gases and highlighted the importance of considering cumulative emissions in framing UNFCC policies. Section 1(a) of the submission explicitly states that Indian concept of equity lies in the principle that each human being receives the same right to the common atmospheric resource and urge for convergence of per capita emissions of developing and industrialized countries (Government of India 2007). The stated stance has been reiterated by India's Prime Ministers on several occasions and it is also further enshrined in the National Action Plan on Climate Change. It also reflects the fact that India's adaptive capacity is in conformity with the per capita emission allowances. India's energy portfolios outlined by Planning commission of India reveal that the projected scenarios are not in conformity (rather largely diverging) to the 2°C guard rail (Singh 2011). The WBGU proposal links it to a market framework so that adequate finances for a transition to low carbon economy can be raised.

3.2 Sectoral emissions and emission reduction

There is a debate, whether India is to be treated as a major GHG emitter or as a disadvantaged newcomer. According to the World Resources Institute, India's estimated CO2 emissions from fossils based sources in 2007 was 1.410Gt as compared to 0.817Gt by Germany and 5.826Gt by the US. India ranks 9th globally with regards to cumulative CO2 emissions (excluding Land-Use Change and Forestry) for the 1850-2007 period with 2.44% contribution. But its economic sectors differ significantly in their relative shares to total GHG and CO2 emissions (see table 1).

Table 1: India's Contribution to GHG emissions by sector, 2005 a

Sector	Share in total GHG emissions (%)	Share of total CO2 emissions (%)
Energy transformation/use	67.0	94.1
Electricity/heat	37.2	56.3
Manufacturing/ construction	13.4	20.6
Transportation	5.3	8.0
Other fuel combustions	8.6	9.4
Fugitive emission	2.5	0.2
Industrial processes	4.7	5.9
Waste	6.7	-
Agriculture	21.6	- b

a Note: Emissions from Land use change and forestry are excluded
b Note: Several authors attribute indirect CO2 emissions to the agricultural sector. Indirect sources are fertilizer and pesticide and machinery production; direct emissions from the use of fossil fuels for agricultural production, soils and burning of residues.

Energy transformation and use are responsible for 94.1% of India's total CO2 emissions. The Indian energy system is largely based on coal and is projected to remain so in the future. The country holds 5.7% of world's proven coal reserves (Tiwari 2000) and politically, coal represents energy security. Other major source of carbon emissions is industrial processes (5.9%) while CO2 emissions from agriculture and disposable waste are negligible.

3.3 Distribution of per capita emissions

With per capita emissions of 1.2t CO2 per year in 2005, India's is one of the lowest emitters in the world in per capita terms. Nevertheless, individual carbon emissions within in India differ, though this fact is little reflected in literature and the climate policy discussion. A deeper understanding of the national inequities in energy use and and access is vital in appreciating the factors underlying the low per capita emission figures for India. These inequalities are reflected in their CO2 emissions (Pachauri 2004; Ananthapadmanabhan et al.) as explained in table 2. Parikh et al. reports that 10% urban residents belonging to the highest income class of the Indian population accounted for 4 tonnes CO2 emissions per capita per year which is one fifth of the per capita emissions in the US while the bottom 10% of the rural dwellers accounted for only 0.15 tonnes CO2 emission/capita/year. The same study also reports that 28% of Indians living in urban areas accounts for 49% of emissions. Such a deeper division in emission profiles is further engrained in the fact that 800 million Indians emit less than 1.55t CO2 per year with about 430 million even below 1.1t.

Table 2: Population, Expenditure class and CO_2 emissions in India 2003-2004

Expenditure Class (2003-04)	**Population (millions)**		**CO2 emissions (tonnes/capita/year)**	
	rural	urban	rural	urban
EC1 very poor EC2 (poor below poverty line)	77.2 154.4	30.0 60.0	0.15 0.215	0.272 0.432
EC3 average	308.7	120.1	0.336	0.802
EC4 above average	154.4	60.0	0.677	1.567
EC5 relatively well off	77.2	30.0	1.365	4.099

Note: EC1, EC2, EC3, EC4 and EC5 represent 10%, 20%, 40%, 20% and 10% of the rural/urban population arranged in ascending order of per capita monthly expenditure, respectively.
Source: Distribution of population and income class from SAM 2003–04 (Saluja and Yadav 2006); CO2 emissions per income class (Parikh et al. 2009).

Let us further analyse the factors behind the low energy consumption profile. It is to be noted that the number of poor people (living under 1.25 dollars per day) increased from 420 million (1981) to 455 million (2005) in India despite a massive reduction of 18% in poverty incidence with in this time span (Chen and Ravallion 2008). This economic backwardness is reflected in energy consumption. The per capita electricity consumption stands at 481Kwh which is 1/5th of world average of 2596KWh (IEA 2007). It is to be stressed that only 1/6th of the population is using more than 100Kwh per year (Rao et al. 2009) and currently 380 million people (in 2005) are living without access to electricity. Vegetarianism (meat consumption is 5.2 kilogram per capita versus 39.7 kilogram world average (World Resources Institute 2007; Rao et al. 2009)), use of public transport, walking and cycling as means of transportation, use of biomass for cooking (Parikh and Parikh 2011), low ownership of transport vehicles (12 vehicles per thousand people compared to 775 in

North America in 2003; World Resources Institute 2007; Rao et al. 2009), high level of recycling (recycling ratio is 70% compared to 30% in US) of materials (Ministry of Environment and forests, India 2007) are the other factors contributing to low emission figures of Indian population in addition to low use of electricity.

We may conclude that agriculture-based and low-consumption lifestyles of the majority of the Indian population have led to the present low per capita emissions. Only the urban better-off societal groups are moving towards emission levels of industrialized states. More than 200 million urban and almost 700 million rural dwellers emit less than 1t/CO2/year (roughly 2/3rd of rural dwellers emit even below 0.4t CO2). In this scenario, it is to be stressed that future emission behaviour of these low emitters is of key importance to the goal of achieving any global emission targets.

3.4 Future emission paths

In 1994, India's initial communication to the UNFCCC was that 1.229Gt equivalent carbon dioxide (CO2e) of anthropogenic greenhouse gases (GHG) were emitted from India. The emission of CO2 alone was 0.793Gt, which increased to 1.5Gt in 2008. This dramatic increase was triggered by high economic growth rates. If such growth rates are sustained, countries like India and China could account more than half of the global increase in the demand for primary energy by 2030. In the urban front, rapid urbanization with emerging mega cities longing for more energy and infrastructure (Kantikar et al. 2009) and in the rural front, demand for electrification, demand for motorised mobility and agricultural energy requirements due to extensive mechanization will aggravate India's energy demand.

Several authors have elaborated emission scenarios for India predicting a massive increase in emissions by 2030. In 2009, the Indian Government released a combined report of five modelling studies estimating future emission scenarios. Per capita GHG emission by 2030-31 has been postulated to vary from 2.77 to 5.00t of CO2, while in absolute terms, India's GHG emissions by 2031 might vary from 4.0 billion tonnes to 7.3 billion tonnes. Four of the five studies estimated that India's GHG emission would stay under 4t/capita. As compared to global average emission of 4.22t CO2 in 2005, even two decades from now, India's per capita GHG emissions would be well below the global average registered 6 years ago (see figure 1).

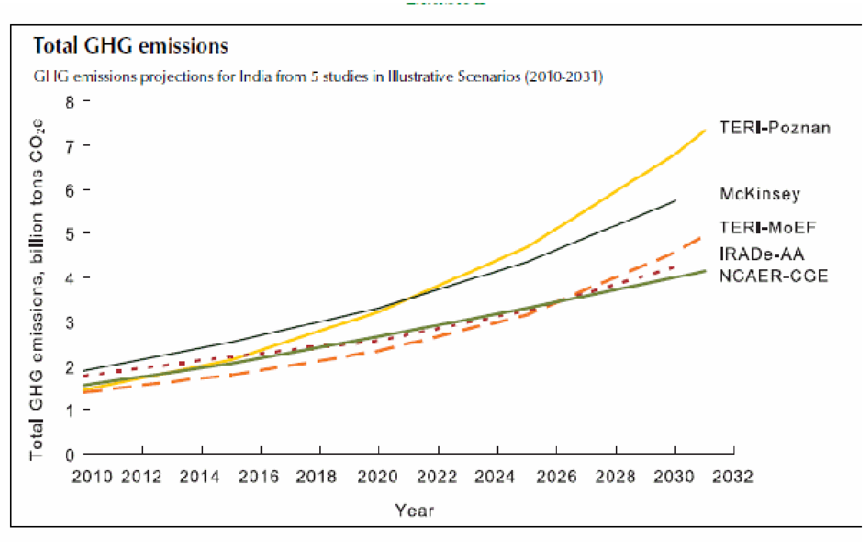

Figure 1: GHG emissions from India (Source: Climate Modelling Forum)

India's future emission scenarios now largely depend on national policies. Strong incentives are needed for motivating authorities, companies and individuals to invest on emission saving through introducing energy efficient technologies and other low-carbon options (Urban et al. 2009). Following the WBGU, adequate incentives for a low carbon growth could be obtained through emission trading.

4. Applying WBGU to India as a case study What does the WBGU approach mean to India in the context of predicted GHG emission pathways?

4.1 Tradable carbon surplus stems from the poor

If the per capita emission allowance approach of WBGU becomes the core principle of UNFCC, India will be able to offer substantial tradable surplus (estimated 1.7Gt CO2 in 2008) for the countries that may incur deficit rights during the transition to the low carbon economy. As discussed already, such a surplus is stemming from the low emission life style of the poorer section of the Indian society. One interesting question is how long the Indian society will be able to provide a substantial tradable carbon surplus? And how those Indians staying below a carbon footprint of 2.7t CO2 per capita per year will be rewarded?

It is a matter of fact that the poorer the people and the worse their access to infrastructure and power supply (fossil fuel based), the lower will be their carbon foot prints and the higher their tradable budget. We assume, in an Indian scenario, that contribution to surplus budget is correlated to the level of development at the individual level as well as living conditions and life style of various social groups. We therefore suggest considering the less and least developed sections of the Indian society as a decisive factor in coping with CC as they provide deferment for the high emission groups within the country and abroad. Their surplus budget can be used as a window of opportunity for implementing emission reductions and decarbonisation. Nevertheless, the poorer sections may not remain poor and may increase their carbon foot print rapidly. Hence their source of primary energy for their future needs must come from non carbon sources if the world has to sustainably use their surplus budgets.

4.2 CO2 surplus budget for low carbon development in rural India

In a previous section of this article we mentioned that in 2008, India emitted roughly 1.5Gt CO2 which was 1.7Gt CO2 below its WGBU budget of 3.2Gt CO2. This calculation says that if future emissions stayed at their 2008 levels, India could annually sell 1.7Gt of CO2 emission allowances and still maintain its sustainability mark. The annual mean of CO2 certificates amounts to approximately 15 €/t. Given these values, about 25.5 billion Euros could have been obtained from carbon trade in 2010. If we consider, a WBGU-like agreement would turn CO2 into a scarce resource, the carbon prices may show an increasing trend, given the diminishing availability of tradable carbon budget. This might be a strong argument for spending a good portion of India's carbon trade revenues on low carbon development of rural areas. In addition, a part of the funds raised by trading can be used for financing adaptation efforts in rural India due to their high dependence agriculture, which is most vulnerable sector to climate change (O'Brien 2004; Prabhakar and Shaw 2008).

4.3 Sustaining the surplus budgets

For analysing the potential of trading CO2 surplus budgets as means to buffer the shortfall of emission rights in industrialised countries during the path to decarbonisation and way to finance climate friendly development in India, dynamic aspects must also be considered. It is of critical importance that a great part of the generated funds are invested in meeting the future energy demands from non (or low) carbon sources and reducing the current dependence on coal based energy so that India will be able to provide tradable carbon surplus during the whole transition period. The expected prices for emission rights may be highly relevant in this respect. The higher the expected prices for rights, the stronger will be the incentives for low carbon energy investments. Investing for low carbon future for rural areas in India is central as most of the current low emitters are rural residents. Further research and administration of pilot projects may give additional insights on possible ways of sustaining the tradable budget.

In addition to the supply side action, it needs to be considered also from the demand side so that the surplus budget can be sustained. While clean energy generation is a supply side strategy, the consumer's perspective brings in the demand side. Compensating the low consumption lifestyles can also be an instrument to sustain the surplus budgets. But little work has been done on personal or locally aggregated carbon emissions in India. It is a big task for the scientific community to devise resilient means for providing a sound data-set that could serve as legal basis for compensation payments. The integration of the rapid changes which take place in lifestyles and consumption habits may turn to be a challenging task in this respect. Following WBGU approach, we suggest that it is a worthwhile effort to estimate on personal carbon footprints or local (e. g.: village) aggregates that reflects the climate relevance of different life styles and consumption habits.

4.4 The limits of trading CO2

India's CO2 emissions have increased rapidly during the last 20 years and are expected to do so at an even faster pace in the near future (as shown in figure 1). As stated before, several studies indicate that Indian per capita emissions could exceed the 2.7t CO2 sustainability mark as projected by WBGU within three decades from now. It means an opportunity to pursue cost effective decarbonisation of the industrialised world (while meeting the 2°C target) using the surplus budget represented by the low emission profile of millions of Indians is fast closing unless their transition to a carbon extensive economy is financed by a global arrangement. The sooner the start of such an agreement embodying the WBGU approach better will be both the global society and India.

4.5 GHGs emissions other than CO2

Nevertheless, agriculture as a sector accounts for 10-12% of total global anthropogenic emissions of greenhouse gases. In case of India, agriculture accounts for roughly 1/3rd of India's national emission of CO2 equivalents with mainly methane stemming from deepwater rice cultivation, livestock and manure management, and nitrous oxide (N2O) emissions mainly from fertilizer application. In addition black carbon from the burning of biomass as prevalent in in Indian rural households may also contribute to the global warming (Menon et al. 2002). Reducing greenhouse gas emissions from agriculture sector could add additional value to less carbon intensive practices of the rural society. Nevertheless, a fruitful discussion on non-CO2 greenhouse gases management is beyond the scope of this paper.

5. Summary and conclusions

A global mechanism is immediately required to mitigate potentially dangerous climate change attributed to building up of atmospheric greenhouse gases emitted from human activities. The German Advisory Board of Global Change (WBGU) suggests the integration of the 2°C as a tolerable limit of warming and a compatible legally binding global carbon budget. It further recommends distributing the carbon budget on per capita basis and also setting up of a world climate bank for supervising national decarbonization and emission trade roadmaps. We do perceive WBGU approach as a paradigm shift in environmental roadmaps and climate policy due to its robust science based mandate and the focus on global cumulative emissions. The framework also foresees payments from the industrialized world to developing countries to compensate for their high emission rates. These could be a major incentive for developing countries to engage in emission reduction measures and low carbon development in presence of an effective institutional framework. In addition, any international climate policy intending to reduce emissions ultimately tends to equate per capita emissions and hence the arguments against the short term disadvantages of industrialised countries in accepting the per capita emission limits is not a worthwhile pursuit.

Given the prominence of India under the WBGU framework, we have analyzed factors behind the low per capita emission pattern and requirements to sustain such a profile. India's lower income groups especially the rural poor currently pursue a low carbon life style and hence provide "carbon surplus" that buffers the high emissions from upper income groups in India and beyond. In a business as usual scenario, today's low emitters of India could transform to high emitters and hence closing the tradable carbon space within 30 years. It means that a cost effective decarbonisation of industrialised countries using the surplus budget (still meeting the tolerable warming limit) is possible only if a mechanism similar to WBGU is in place as soon as possible.

If a system of an international carbon trade based on per capita emission allocation turned into reality, substantial resources can be generated that can eventually lead India (and also other low emitting countries) to a low carbon growth path. In order to maintain tradable carbon stocks, India would have to enforce supply side strategies on primary energy provision fostering low-carbon development of the rural dwellers and reducing the dependence on coal based energy as well as compensating the low carbon lifestyle of rural residents as a demand management strategy. In addition a part of the funds raised also can be used for adaptation and hence the mitigation efforts can be linked to adaptation on a larger scale.

In a nutshell, the WBGU approach offers a promising way of handling CO2 emissions (combining climate science with economics) that can potentially meet emission reduction needs of globally accepted 2°C guard rail while accommodating the development requirements of developing countries like India. Hence it offers a sound basis for discussions on a global climate treaty.