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Reconciling Human Development and Climate Protection: Perspectives from Developing Countries on Post-2012 International Climate Change Policy

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*Reconciling Human Development and
Climate Protection:
Perspectives from Developing Countries on
Post-2012 International Climate Change
Policy*

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THE HARVARD PROJECT ON INTERNATIONAL CLIMATE AGREEMENTS

The goal of the Harvard Project on International Climate Agreements is to help identify key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for global climate change. It draws upon leading thinkers from academia, private industry, government, and non-governmental organizations from around the world to construct a small set of promising policy frameworks and then disseminate and discuss the design elements and frameworks with decision-makers. The Project is co-directed by Robert N. Stavins, Albert Pratt Professor of Business and Government, John F. Kennedy School of Government, Harvard University, and Joseph E. Aldy, Fellow, Resources for the Future. For more information, see the Project's website: <http://belfercenter.ksg.harvard.edu/climate>

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Reconciling Human Development and Climate Protection

Perspectives from Developing Countries on Post-2012 International

Climate Change Policy

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Executive Summary

Human activity is causing irreversible harm to the climate system and environment. The Kyoto Protocol is only a good starting point to raise the awareness of climate change. However, this protocol failed to address some core issues, such as setting targets based on a fair and efficient burden-sharing principle, effectively engaging developing countries, setting a long-term goal, implementing cost-effective policy instruments with given binding target, non-compliance penalties and etc. Therefore, whether society can stabilize the global climate without stifling development aspirations, would rely on whether we can design a fair and efficient climate change policy architecture for the post-2012 era.

For this purpose, this paper provides a new multi-stage climate policy framework based on a revised Global Development Right (GDR) calculation, and proposes a feasible hybrid negotiation framework from the perspective of developing countries. According to the “common but differentiated responsibilities and respective capabilities” principle in the United Nations Framework Convention on Climate Change (UNFCCC), we recognize that due to the historical emissions contributions and different pace of industrialization and growth around the world, a successful international climate policy needs to balance equity and efficiency and eventually achieve an overall carbon mitigation target.

In this paper, we first discuss a multi-stage framework to gradually engage developing countries, which can be adapted to incorporate Kyoto Protocol flexibility instruments

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such as cap-and-trade. Then we propose a clear and potentially acceptable burden-sharing principle, by balancing equity and efficiencies, capacity and responsibility through a global development right (GDR) framework. We extend the original GDR calculations in Baer, Athanasiou and Kartha (2007), by incorporating cumulative historical carbon emissions back to the 19th century, and taking into account carbon sinks in the burden-sharing framework. Though all greenhouse gases would in principle be covered, this paper only address fossil fuel based carbon emissions, which contribute to 76% of global warming effects (USEPA, 2006). Extensions can be easily made to incorporate all greenhouse gases using historical accumulative by-country non-GHG emission data. For the practical matters, we also discuss a hybrid negotiation framework and how it can integrate the proposed GDR burden-sharing framework. Finally, to illustrate the developing country perspective, we use China as an example to present the possible opportunities and future challenges in coping with the future climate crisis.

In sum, climate change is a very complicated problem that requires an urgent, fair and effective international climate change policy regime. The sooner we can break the current political climate impasse, and build the post-2012 architecture, the better chances we will have to stabilize the global climate for our future generations.

1. Introduction

Human activity is causing irreversible harm to the climate system and the global environment. The atmospheric concentrations of carbon dioxide and other GHGs are rising rapidly, and largely responsible for increasing the earth's average surface temperature by 0.7 degrees Celsius of the past century (IPCC 2007). The Kyoto Protocol is the first step by the international community along the road to combat *climate change*. However, this is just the initial step toward a comprehensive global framework to realistically solve the problem. Much of the criticism of the Kyoto Protocol is over political realities and limitations on the treaty itself. In particular, with the withdrawal of the United States and exemption from the developing countries like China and India, the Protocol is not designed to stabilize the global climate. However, the lessons learned from the implementation of the Kyoto Protocol and endless international negotiations in the last two decades offers opportunities to establish a more realistic political framework to combat climate change, and its success will rely on solving the economic and humanitarian problems of climate change at the same time.

After the Bali conference provided a future road map and time table in late 2007, a formal negotiating process has been launched, such as the ad hoc working group (under the Convention) on long-term cooperative action (AWG-LCA) and ad hoc working group (under the Kyoto Protocol) on further commitments for Annex I parties (AWG-KP). Much activity and studies have started among research institutes, governments, business, and NGOs regarding the post-2012 climate change policy architecture design. The major themes that are arising for discussion and negotiation are encouraging developing country participation, strengthening the emission reduction

targets of current Kyoto Protocol developed countries, and ensuring engagement and compatibility with the USA domestic climate change policy, as well as equity and humanitarian issues, and improving the negotiating process to speed up effective international agreements.

Currently, some researchers advocate a “continue Kyoto” proposal, with essentially key approaches from the Kyoto Protocol, such as keeping Annex I and non-Annex I country categories, continuing the Kyoto flexibility mechanisms such as emission trading (ET), joint implementation (JI) and clean development mechanism (CDM), or through an extended Kyoto framework, a so-called “Kyoto Plus” proposal. Other proposals, on the contrary, treat the Kyoto Protocol as an inevitable failure in combating climate change, suggest initiating an alternative new negotiation and policy framework to replace the Kyoto approach completely. For example, Victor (2004, 2007) discussed in depth the protocol’s inevitable failure, and instead he proposed an alternative approach based on extensive use of nonbinding agreements for fragmented emission trading systems, and offering incentives for engaging developing countries. Richard Cooper also suggested using an alternative harmonized carbon tax to replace Kyoto Protocol (Cooper, 2008).

For most researchers, the proposed post-2012 climate change framework usually mixed both conventional “Kyoto instruments” such as emission trading, extended CDM with carbon sinks, technology-based CDM projects, and new elements or policy designs such as sectoral based emission trading, hybrid emission trading system, equal carbon right and trading regime, R&D, geo-engineering, etc (McKibbin and Wilcoxon, 2007; Barrett, 2007; Pizer 2007; Sawa, 2008; Teng,2008).

Almost all the post-2012 proposals recognize, no matter how different each proposal may present in terms of policy design or instruments, a future realistic regime proposal would inevitably rely on successful engagement of developing countries. Most of the previous proposals provide insights on various elements of a potentially realistic and successful policy regime, however still much is left to discuss on how to break the current political impasse between the developed and the developing country negotiators. In particular, currently, as the biggest carbon emitter in the world, China is playing a more and more important role in this climate battle and is also expected to lead the other developing countries in future climate change treaty negotiations.

In contrast with most of the previous climate proposals, in this paper, we will focus more on how to realistically break the political impasse through a multi-stage framework with differentiated targets and timetables, and propose a more practical and fair burden-sharing rule – an extended greenhouse development right (extended GDR) to reconcile future human development and climate change challenges. We also examine how this climate structure can be linked with the flexible Kyoto market-based mechanisms. We emphasize the role of and adaptation, technology, finance, research, and how these interact in a proposed post-2012 climate change policy regime. In particular, we discuss China’s role in the climate change international framework and how

this may contribute to China's own sustainable development.

The paper is structured as follows. In section 2, we sketch out a multi-stage climate change negotiation framework as a following stage after the Kyoto Protocol, and emphasize key principles to achieve a realistic climate agreement that can break the current political impasse between the developed and developing country negotiators. In section 3, we propose a new burden-sharing rule that would fulfill the UNFCCC principle of "common but differentiated responsibilities and respective capabilities" by extending Baer, Athanasiou and Kartha's Greenhouse Development Rights (GDRs) framework. Then in section 4, we present a feasible multi-stage hybrid structure for a realistic implementation among countries, and illustrate how this new burden-sharing rule can be applied successfully in conjunction with other elements of a post-Kyoto policy architecture. In section 5, we focus on developing countries' perspective on climate change using China as a case study to discuss the opportunities and challenges for future climate change negotiation. We emphasize the potential gain for China in reconciling its economic reform goal and global climate efforts under this multi-stage climate framework. Section 6 concludes the paper.

2. A Multi-Stage Climate Change Negotiation Framework: Key Elements and Challenges

Climate change is a long-term challenge characterized by uncertainty in both science and economics. Thus, climate change negotiations should not focus on a short-term fix but rather on long-term concepts. However, it is not realistic to negotiate an agreement over 20, 50 or even 100 years. Thus, a realistic structure would ideally include a multi-stage climate change framework dealing with a long time horizon but accessible and relatively short-term targets for each stage.

Currently, many researchers have proposed that countries participate in the climate change negotiation through multiple stages with differentiated targets and commitments as either a continuous graduation and deepening (Michaelowa, 2007) or discrete stages (Claussen and McNeilly 1998; Gupta 1998; Berk and den Elzen 2001; Blanchard et al. 2003; CAN 2003; Criqui et al. 2003; den Elzen et al. 2003; Gupta 2003; Höhne et al. 2003; Ott et al. 2004; Blok et al. 2005; den Elzen 2005; den Elzen et al. 2005b; Höhne et al. 2005a; Michaelowa et al. 2005; den Elzen et al. 2006; Höhne 2006).

A long-term multi-stage international climate negotiation framework can easily be adapted to the changing circumstances as we resolve uncertainty in the future in terms of scientific knowledge, mitigation, and/or adaptation costs, and technology breakthroughs. Similar to the idea raised by Höhne (2006), our multi-stage proposal for such stage division can be defined as:

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- **Deepening the Kyoto Protocol commitments for developed countries (DCs), and no commitment for less developed countries (LDCs).** In the first stage of the post-2012 climate era, it is very unlikely that all the LDCs will accept GHG targets, thus development is given the first priority for the LDCs to catch up with the developed countries, and increase capacity building on both climate mitigation and adaptation. The old delineation between Annex I and Non-Annex I countries need to be revise, for countries such as Singapore and South Korea might join the Annex I group, depending on whether we use per capita income or per capita CO₂ emissions as criteria, thus more countries will be joining the committed carbon reductions.
 - **Enhanced sustainable development with voluntary reduction of GHG emissions in LDCs.** Some emerging LDCs such as China and India, which have experienced economic growth around 8-10% in recent years, are becoming more and more capable to participate in GHG reduction activities. If the trend of future economic growth can keep a similar pace, a sustainable development pathway should be defined with both development and environmental objectives. This would include a gradual phase-out of inefficient and energy-intensive equipment and new investment and standards to meet new sustainable development criteria. In this stage, LDCs can be allowed to trade with other developed countries, or voluntarily reduce GHG emissions domestically along with local sustainable development.
 - **Moderate GHG mitigation target for LDCs.** When some less developed countries are catching up, i.e. reaching a certain degree of economic development, these countries need to commit to a moderate target for GHG reduction. A moderate GHG mitigation target is only binding in one direction, that is, if the target is exceeded, the allowances can be sold; but if the target is not achieved, no allowances have to be bought (Höhne (2006). Or as Aldy, Baron and Tubiana (2003) suggested, non-binding – or “no lose” targets for developing countries to experiment with emission mitigation efforts. In practice, if developing countries adopt some kind of abatement efforts, such as domestic carbon tax and achieve a lower carbon emission path than forecast baseline, they can sell the “excess” allowances to countries with binding commitments.
 - **Binding and absolute GHG mitigation target at the global level.** In the last stage, all the developed countries and LDCs face binding and absolute GHG mitigation target. How much each individual country has to reduce their emissions or assume responsibilities will be addressed in the later section focusing on burden-sharing rules and extended GDR calculations.

The merit and critical issue about this multi-stage framework is to ensure that a sufficient number of countries are involved and subsequently move from lower stage to higher stages. Regular reviews of each country’s profile and assessment of whether it graduates to the next stage would be necessary for such a scheme. This will inevitably require a

well-designed organizational institution to undertake such a mission.

Besides the consideration on the stage division and organizational institution scheme, a realistic multi-stage framework also relies on the following key elements: legally binding emission targets at each stage, broad coverage of country participation, a fair and efficient burden-sharing rule within member or club countries, a well-designed market system with incentives for reducing mitigation costs, and a binding enforcement scheme.

Define the GHG concentration target

Ideally, a cost-benefit approach can be used to assess policy options for decision making. However, in the context of climate change, uncertainty about climate science, potential mitigation and adaptation costs, and technology breakthroughs, as well as the difficulty in determining an appropriate long-term discount rate, significantly complicates the use of cost-benefit analysis for climate change decision making. Instead, many scholars turn to its alternative, cost-effective attainment of a pre-determined emission or concentration target (Michaelowa, 2007, Baumol and Oates, 1971). For this manner, it is important that the pre-determined target is close to the optimal level of GHG concentration, otherwise the cost-effective approach to a wrong target would lead to in-efficient outcome. The Kyoto Protocol sets a target for all the developed countries at around 5% below 1990 levels of six types of greenhouse gases. However, the inconvenient truth is this target is still too modest to actually make a difference on the future climate trajectory.

So in the first stage, all member countries need to agree on a path of future global emissions that leads to an agreed long term stabilization level for GHG concentrations. For economists, it is not out task to justify what emission pathway may lead to the 2°C threshold, rather this should rely on the updated IPCC assessment reports. Although the Stern Review gives a full-fledged complicated study on cost benefit analysis of carbon mitigations, it recommends stabilization of GHG emissions to around 550ppm CO₂e around 2050, and suggests the cost is modest at around 1% of World GDP, which could be borne by most economies without major disruption (Stern, 2006). It was still criticized by many scholars. Nordhaus (2007) and Weitzman (2007) both point out, this big benefit cost ratio primarily due to the assumption of a very low time discount rate with a specific utility function. Besides the discount rate assumption, using relatively high damage costs and relatively low mitigation costs in the review, Weyant (2008) also criticizes Stern's "one shot" benefit cost analysis, rather than solving a problem of sequential decision-making under uncertainty.

Therefore, considering the agreed climate threshold, concentration, potential costs and benefits may change with the development of future research, the future global emission path needs to be assessed frequently and adjusted to new assessments. As Michaelowa (2007) suggested, when each new IPCC assessment report triggers a reassessment of the emission path and concentration targets, the global target in the policy framework needs to be adjusted correspondingly, thus a multi-stage framework with different time tables can easily adapt to new scenarios and new assessments.

Participation Coverage:

A well-designed post-2012 climate architecture must include broad country participation. While the Kyoto Protocol has more than 150 signatory countries, only a small portion of them really have obligations to cut their GHG emissions. The United States and China, emitting about 42-45% of global carbon emissions in recent years¹, are not subjected to quantitative targets. In addition, for most of the less developed countries, earnest engagement in climate change would cause more to lose than to gain. For the developed countries, even the modest 5% reduction in the Kyoto Protocol had to go through very time-consuming and difficult negotiations. Further more aggressive targets may eventually lead to a political impasse.

Breaking the political impasse and increasing participation and compliance in international climate change policy is the key in this battle against climate catastrophe. In particular, an international agreement should aim to attract less developed countries to participate by reducing GHG emissions without jeopardizing their right to development. In the next section, we will discuss a burden-sharing rule with common but differentiated responsibilities and respective capacities, putting developing countries' development at its structural core. We show how this rule can fit into our proposed multi-stage climate proposal to broaden participation.

Burden Sharing – Common but Differentiated Responsibilities and Respective Capacities

Defining an internationally fair and effective distribution of the burdens of reducing climate change risks has been a core element to the climate negotiations. The principle should be tailored for each country to fulfill the UNFCCC principle of “common but differentiated responsibilities and respective capacities”. Differentiated abatement needs to be calibrated to meet the climate challenge, self-enforced feasible. The difficult political impasse in the climate negotiations is mainly driven from the debate over the equitable sharing of the burden to curb climate change. Developing countries continue to press the claim that developed countries should deepen their targets given their historical responsibilities. Developed countries on the other hand claim that, in the long-run developing countries are likely to be the major GHG emitters, and they need greater assurance when and how developing countries would start taking on binding commitments. A widely accepted burden-sharing rule setting equity and development as core principles, would be the key to resolve the debate between developed and developing countries, and bring most of the LDCs negotiators to move voluntarily toward a globally collective goal of reducing GHG emissions. In the next section, we will focus on a extended burden-sharing approaches to broaden and deepen the current global efforts on climate change.

¹ <http://www.mnp.nl/en/publications/2008/GlobalCO2emissionsthrough2007.html>; raw data is from IEA (2007) and BP Review of Energy (2008)

Role of Flexible Mechanisms

In this multi-stage post-2012 climate architecture framework, cost-effective implementation through emission trading or a carbon tax ensures attainment of the defined GHG emissions and concentrations targets. The future architecture's success will rely on the review of existing flexible mechanisms and investigation of further mechanisms and how these would attract less developed countries to participate in the global mitigation effort.

Binding Commitment and Punishment Scheme

Last but not least, a clear accountability system must have the ability to ensure that each country implements and complies with its commitments. The Kyoto Protocol has an enforcement mechanism, but it is not likely to be binding in practice. Countries that have exceeded their emission targets during one period are required to reduce emissions enough in the next period to make up for the excess in the previous period, plus an additional 30 percent. However, a country that fails to achieve its target in the first period may fail in the second commitment period and may have no intentions ever to fulfill the commitment. Thus, more stringent sanctions for non-compliance and punishment schemes are necessary to ensure that no member country will deviate. It could be either to satisfy the self-interest of the participants, or design more credible and meaningful punishment scheme such as trade sanctions.

Challenges for this framework:

The current political impasse might pose more costs through delaying of climate change mitigation efforts. The multi-stage climate framework puts different countries under one common regime, while it also accommodates different countries' development priorities and reconciles these in parallel with a multi-stage climate change efforts. In addition, a staged and parallel setting system can accommodate both flexibility and overall mitigation target, so it would be more likely than the ad-hoc sequential negotiation and decision making process following Kyoto Protocol, although the latter only established two stages – Annex I and non Annex I – without creating any intermediate stages. The critical challenge of this framework is to broaden the participating countries as early as possible, so that stringent climate mitigation goals can be reached. Therefore, to break the current political impasse, it is crucial to give less developed countries incentives for such a multi-stage participation.

3. Reconciling Equity and Climate Protection: A Global Allocation

System

To achieve significant reductions in GHG emissions, a self-enforcing climate agreement needs to broaden the participant coverage and deepen the mitigation goals. Currently, the OECD countries, a few big developing countries (China, India and Brazil), and eastern Europe, Russia and Ukraine, account for most of the current and future GHG emissions. An international climate agreement involves only a subset of the world's emitters will

lead to carbon leakages to non-participating countries undermining the environmental benefits of the agreement. To guarantee broad country coverage and break the current north-south climate negotiation impasse, it is important to work out a fair framework for an alliance of both the north and south: since the North itself cannot stabilize the climate without the full commitment of the South, and the South cannot agree with any commitment if it will jeopardize its development. Thus an equitable and effective burden-sharing allocation system is necessary to ensure the rich countries not only deepen their own mitigation targets, but also do whatever they can to help the poor countries to develop, increase their capacity to adapt and mitigate their emissions for a low-carbon future.

Burden-Share Criteria:

To design a scheme of burden sharing that can be accepted as “fair” by all or at least most governments, the following factors need to be considered:

1. ***The size of economy:*** This simply states that a country with a large economy, with more capacity and more responsibility, needs to contribute more climate change mitigation.
2. ***Historical contribution to the current global warming.*** It is important to build in the element of historical responsibility in the burden-sharing design. Without taking into account the historical contribution, it is very unlikely that LDCs will get involved.
3. ***The right to development.*** A global climate architecture must embrace sustainable development as its core element, that is, to satisfy the fundamental needs of poor countries and improve their capacity toward adapting to and mitigating climate change impacts.
4. ***Controlling carbon leakage:*** since non-participating countries could manufacture energy-intensive goods and export them to countries with binding commitments, policies such as border tax adjustments, or a consumption-based carbon tax should be incorporated.
5. ***Other country-specific characteristics:*** the international agreement should account for other special factors such as carbon-intensive (coal) or carbon-free (hydropower) energy endowments; the climate policy implications on income distributions, etc.

Greenhouse Development Rights (GDRs) Framework

Baer, Athanasiou and Kartha (2007) first proposed a new burden sharing framework - Greenhouse Development Rights (GDRs) Framework considering both sustainable development and equity issues for LDCs, by defining Capacity (C), Responsibility (R) and a Responsibility and Capacity Indicator (RCI) as a weighting product of the two.

$$C = P \int_{y_{DT}}^{\infty} dy (y - y_{DT}) f(y, \bar{y}, G)$$

where P is the population, y_{DT} is the development threshold, \bar{y} is the per capita

income, G is the Gini coefficient, and $f(y, \bar{y}, G)$ is assumed to be a log-normal income distribution and the Gini coefficient G is fully contained in the variance:

$$\sigma^2(G) = 2 \left[N^{-1} \left((1+G) / 2 \right) \right]^2$$

where N^{-1} is the inverse of the cumulative normal distribution.

Similarly, national responsibility is defined as:

$$R = P \int_{y_{DT}}^{\infty} dy (e(y) - e_{DT}) f(y, \bar{y}, G)$$

where e is emission at a given level of income, and e_{DT} is equal to the emissions of a person whose income is precisely equal to the development threshold. The quantity e_{DT} behaves analogously to the development threshold, as the “emission threshold”, such that only emissions above this threshold contribute to R .

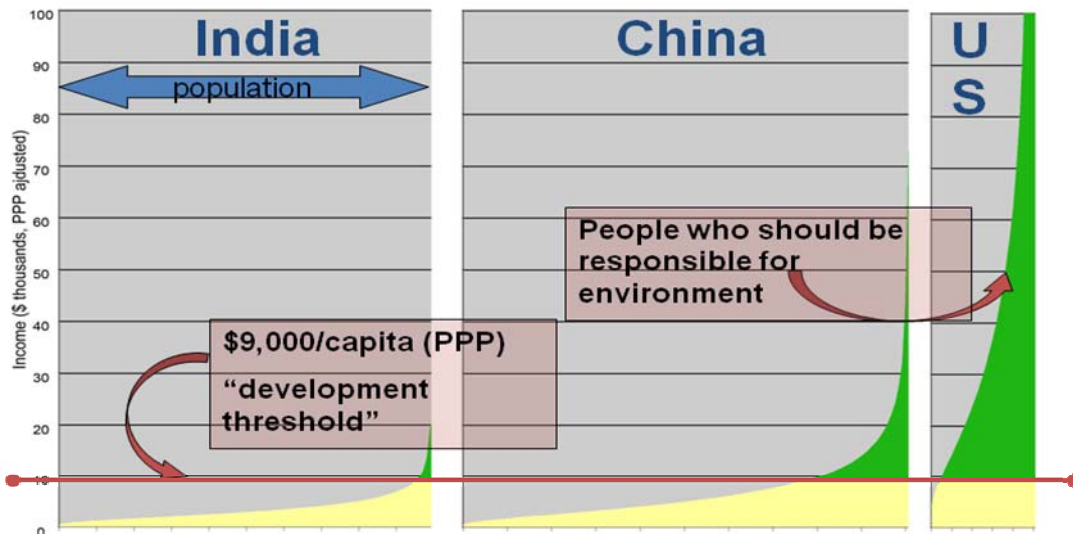
Capacity (C) tells something about the measurement of resources to pay without sacrificing necessities and responsibility (R) indicates one nation’s contribution to the climate problem in the history. The formula is given as follows.

$$RCI = R^a C^b$$

The exogenous weighting parameters a and b , represent people’s ethical judgment on the importance of capacity and responsibilities. For example, $a=0.5$ and $b=0.5$ suggest that capacity and responsibility are weighted equally. Baer, Athanasiou and Kartha (2007) used $a=0.4$ and $b=0.6$ in their reference case, which suggest that capacity is somewhat higher than responsibility.

Unlike national emission allocations at the country level, or sectoral intensity targets focused at the sector level, the GDRs allocation rule are defined in individual terms, and it “*implicitly accounts of the distribution of income and emissions – inequality – within countries*” (Baer, Athanasiou and Kartha, 2007). A combination of per capita income and per capita emission are taken into account to compare with the threshold, and this obliges people with incomes and emissions above the threshold, no matter where they are, to pay the costs of mitigation and adaptation but allows people with incomes and emissions below the threshold to maintain their right to development.

FIGURE 1: ILLUSTRATION OF INCOME AND CAPACITY



Source: Revised from Baer, Athanasiou and Kartha (2007), figure 3. pp36.

Note: National income distributions showing capacity (in green) as fraction of income above the development threshold

Figure 1 gives an example of how the GDR framework can be used to allocate mitigation obligations for three key countries, United States, China and India, with the consideration of population factors, development threshold and capacity factor such as PPP-adjusted income level. For each country, an estimated income distribution is measured based on per capita income and Gini coefficient, shown as the corresponding percentile on the x-axis (from the poorest to the wealthiest), and PPP-adjusted income is shown on the y-axis. In terms of the development threshold or so called “subsistence income,” Baer, Athanasiou and Kartha (2007) pick 150 percent of a poverty line income - \$6,000 in PPP terms. That is, \$9,000 is assumed as the income threshold, which slightly above the global average income (of about \$8,500), to represent for a “global middle class” income level. Given this income threshold, the portion below will be waived for any climate obligations. The area above this development threshold represents each country’s capacity, which could legitimately be taxed to mitigate climate crisis. A similar “emission threshold” is also assumed in this obligation calculation.

Extensions and New Results

Baer, Athanasiou and Kartha (2007) presented a revolutionary idea trying to reunite both DCs and LDCs under the same climate alliance umbrella. However, there are many more specifics that merit consideration under this framework. Both the income threshold and the weighting parameters need to be assessed through a sensitivity analysis. In addition, the emission calculations are in question: should it account only for accumulated emissions since 1990? Or from even further back in history to the state of the industrial revolution? What kind of GHG emissions need to be considered? Fossil-fuel based?

What about the deforestation and afforestation and impacts on calculation of a country's obligation? How would this burden-sharing rule interplay with the post-2012 climate architecture? All of these questions still need to be answered.

In this paper, we made some revisions to the calculations conducted in Baer, Athanasiou and Kartha (2007). First, we use a more comprehensive historical accumulative carbon emission data from 1850-2004². Though all greenhouse gases would in principle be covered, this paper only address fossil fuel based carbon emissions, which contribute to 76% of global warming effects (USEPA, 2006). Extensions can be easily made to incorporate all greenhouse gases using historical accumulative by-country non-GHG emission data.

Here we incorporate some elements of the so-called "Brazilian Proposal" idea, that is, to propose sharing the burden of emission reduction based on the impact of historical GHG emissions. It is very likely that the element of historical responsibility will play an important role in the design of post-2012 climate agreement. However, it is unlikely to be the sole parameter for sharing emission reductions among countries, but will become more likely one of the indicators, as in the above GDR calculations, to determine a country's contribution. In Baer, Athanasiou and Kartha (2007), they only consider the accumulated emissions from 1990-2005, while ignoring all the emissions accumulated from the industrial revolution to 1990, which would be unfair to many developing countries. In particular, many developing countries are still developing by relying on the expansion of their manufacturing sector, while many developed countries have already shift from energy-intensive manufacturing to services. Thus we revise the calculation of accumulative emissions back to 1850 to correct for this bias in their paper.

For many years, the mainstream scientific and policy studies focused only on carbon dioxide emissions from fossil fuel combustion, thus most GHG mitigation policies concentrate on the energy sector. However, atmospheric composition and climate change are also affected by land cover and land use changes as well as non-carbon dioxide greenhouse gases through various bio-geophysical and biogeochemical mechanisms. Land-use changes, mainly deforestation, account for about 20% of global emissions, and land-use associated GHG abatement activities are expected to play an important role in combating future climate change, maybe even greater than the global transport and industrial sectors (Lagos, Wirth, and EL-Ashry, 2007). To address this issue, we revise the original GDR framework by taking into account the carbon sink calculation. The land-use carbon stock change is a very complicated task, so for this preliminary study we only account for the forest based carbon stock and sequestration³ in our framework.

² The accumulative carbon emission data from 1850-2004 is from Climate Analysis Indicators Tool (CAIT) Version 5.0. (Washington, DC: World Resources Institute, 2008)

³ Carbon dioxide sinks means absorbing CO₂ in the following mechanisms: ocean's biological pump, i.e. transport [carbon](#) from the surface [euphotic](#) zone to the ocean's interior, or plants and other organisms that use photosynthesis to remove carbon from the atmosphere by incorporating it into biomass and releasing oxygen into the atmosphere. The process by which carbon dioxide sinks remove CO₂ from the atmosphere is known as "carbon sequestration". Here we refer the carbon sequestration from the land-use change and carbon stock in forestry only in our calculation.

The carbon stock data are based on a recent study by Food and Agriculture Organization of the United Nations (FAO) – Global Forestry Resources Assessment 2005 (FRA 2005)⁴. FRA 2005 is the most comprehensive assessment of the current status and recent trends about the extent, condition, uses, values of forests and other wooded land. Of particular interest, it provides estimates of the accumulated flow of carbon stock in forestry and other wooded land for the year 2005. Since the missing data issue is more prominent for the carbon stock of other wooded land, we focus our study only on forestry.

As for the other data, we use the GDR version 2.0.0 database with updated information on income class categories, per capita incomes (2005 prices with PPP adjustment), Gini coefficients, and national incomes. The summary of the raw data and results of this revised GDR calculation for selected countries and groups of countries are given in table 1. In this calculation, we also adopt the US\$9000 as the development threshold to measure “survival income” as in Baer, Athanasiou and Kartha (2007).

From our calculation, the United States has the highest share of global capacity, the largest share of global responsibility and therefore also the largest share of combined RCI. Based on our revised calculation framework with carbon sink and new cumulative carbon emissions, our calculation of the U.S. share is 5% higher than the results in Baer, Athanasiou and Kartha (2007)⁵. Then following the United States, Germany, Japan, and United Kingdom will need to contribute for 7.8%, 7.8%, and 6.4% respectively. So the four countries count for about 60% of the overall global bills to abate climate crisis. We also calculated the current obligations for developing countries. Based on the new data set, China’s obligation is about 2.2%, India and Brazil would have no obligations, and South Africa has a tiny obligation for 0.7%. Our calculation suggests that all high income countries need to take 87% obligations, all middle countries take about 13% obligations, and all low income countries only need to share 0.1% of the total contributions. Our estimate for high income countries is about 8-9% higher compared to Baer, Athanasiou and Kartha (2007), and 7-8% lower for the all middle income countries, the key is due to the revisions for cumulative emissions, carbon sinks and some data changes in the new version GDR dataset.

Table 2 gives some sensitivity analyses of GDR calculations. The first column gives the original calculation of RCI share in Baer, Athanasiou and Kartha (2007), only with the updated GDR 2.0.0 version data set, so results are slightly different from their original results. For example, in this GDR 2.0.0 version, GDR for China is only 2.7, not 7.0 for the new data set utilized the new revision of China’s PPP estimates from the World Bank. In the second column, we expand the accumulated carbon emissions from 1990-2005 to 1850-2004⁶. We can see that, with the emissions calculated back to 1850s, the US share

⁴ Source: <http://www.fao.org/forestry/fra2005/en/page.jsp>

⁵ Baer, Athanasiou and Kartha (2007) estimated that US share is 34.3%.

⁶ The WDI data is only updated to 2004, so we did not include the emission data in 2005.

would increase by 2% and EU share increase by 4%, and on the other hand all the developing countries' shares are slightly decreased. This is because most of the industrialization process fifty years ago happened in western countries. When we count more historical emissions, those earlier industrialized countries have to face more 'responsibilities', which increases their shares.

In column three, we keep the time horizon for accumulated emissions for 1990-2005, but incorporate carbon sink data from FAO. Due to the large forestry coverage in the United States, the RCI share of US drop by one third, while EU's share increased to about 39%. China has to burden a little more share also, while Russia and Brazil do not need to pay any more because of large area of forest and relatively low population density.

Our preferred calculation is given in column 4. The United States and EU need to contribute about 39% and 36% respectively, which are higher than other alternative calculations. Overall, high income countries at current time need to contribute 87% and middle income country share about 13%, and low income countries are basically waived and only tiny 0.1% share at the time being. Although the developing countries are contributing very little at the beginning, that is, using our 2005 baseline, considering that developing countries are catching up, such as China and India with annual growth rate at 8-10%, more and more people will be above the poverty threshold and need to bear more responsibilities, thus the share of developing countries will be increasing and the share of developed countries will drop over time. Thus in the last two columns, we project a future obligation share by assuming that some developing countries like China and India will have an average GDP growth rate at about 7% annually, while the rest of the developed countries and middle income countries will keep an annual growth rate at 2% for both 1990-2005 and 1850-2004 scenarios. The future carbon emissions are assumed to follow the same pace with the economic growth rate. Then we can see that the share of high income countries drop by roughly 11%. Developing countries will take more responsibility. China needs to contribute about 9.4%, India is about 1.0%, and South Africa is about 0.7%..

TABLE 1: GLOBAL PERCENTAGE SHARE OF POPULATION, INCOME, CAPACITY, CUMULATIVE EMISSIONS, CARBON SINK, RESPONSIBILITY AND GLOBAL RCI FOR SELECTED COUNTRIES AND GROUPS

Country	Population	Income (2005 PPP Adjusted)	Global Capacity	Cumulative Emissions 1850-2004	Carbon Sink	Global Responsibility	Global RCI*
United States	4.7	22.2	33.7	29.5	8.04	43.3	39.3
United Kingdom	0.9	3.4	4.7	6.2	0.04	8.8	6.4
Germany	1.3	4.5	6.1	7.2	0.49	10.0	7.8
France	0.9	3.3	4.5	2.9	0.43	3.9	4.5
Russia	2.2	3.0	2.0	8.2	16.77	2.8	2.4
Japan	2.0	6.9	9.4	3.9	0.70	5.2	7.8
South Korea	0.8	1.8	2.1	0.8	0.11	0.9	1.6
China	20.4	10.0	2.3	8.1	2.78	1.8	2.2
India	17.0	4.2	0.1	2.3	0.97	0.0	0.0
Brazil	2.9	2.8	2.2	0.8	19.46	0.0	0.0
South Africa	0.7	0.7	0.5	1.2	0.74	0.8	0.7
All High Income	15.6	59.1	83.4	62.1	15.70	86.7	86.9
All Middle Income	47.7	33.5	16.5	33.7	62.97	13.2	13.0
All Low Income	36.7	7.4	0.2	4.2	21.34	0.1	0.1

* Here we assume the capacity weight $a=0.6$ and responsibility weight $b=0.4$.

TABLE 2: SENSITIVITY ANALYSIS ON SHARE OF GLOBAL RCI

	Share of Global RCI (%)					
	2005 Baseline				2020 projection	
	1990-2005	1850-2004	1990-2005	1850-2004	1990-2005	1850-2004
Historical CO2 Emissions						
Capacity Weighting	0.6	0.6	0.6	0.6	0.6	0.6
Responsibility Weighting	0.4	0.4	0.4	0.4	0.4	0.4
Estimation Scope	No Carbon Sink	No Carbon Sink	Consider Forestry Sink	Consider Forestry Sink	Consider Forestry Sink	Consider Forestry Sink
United States	36.0	38.0	24.6	39.3	20.5	33.7
EU (27)	30.1	34.0	38.8	35.6	34.3	32.6
- United Kingdom	4.3	6.0	7.1	6.4	6.1	5.6
- Germany	5.9	7.4	8.4	7.8	7.3	7.0
Russia	2.9	2.9	0.0	2.4	0.0	4.5
Japan	8.4	7.5	11.8	7.8	10.2	7.0
Brazil	1.7	1.4	0.0	0.0	0.0	0.0
China	2.7	2.1	3.4	2.2	14.2	9.4
India	0.1	0.0	0.1	0.0	1.3	1.0
South Africa	0.8	0.7	0.0	0.7	0.0	0.7
LDCs	0.0	0.0	0.0	0.0	0.0	0.0
All High Income	82.3	84.2	87.0	86.9	74.8	76.1
All Middle Income	17.6	15.6	12.9	13.0	23.9	22.8
All Low Income	0.1	0.1	0.1	0.1	1.3	1.1
World	100.0	100.0	100.0	100.0	100.0	100.0

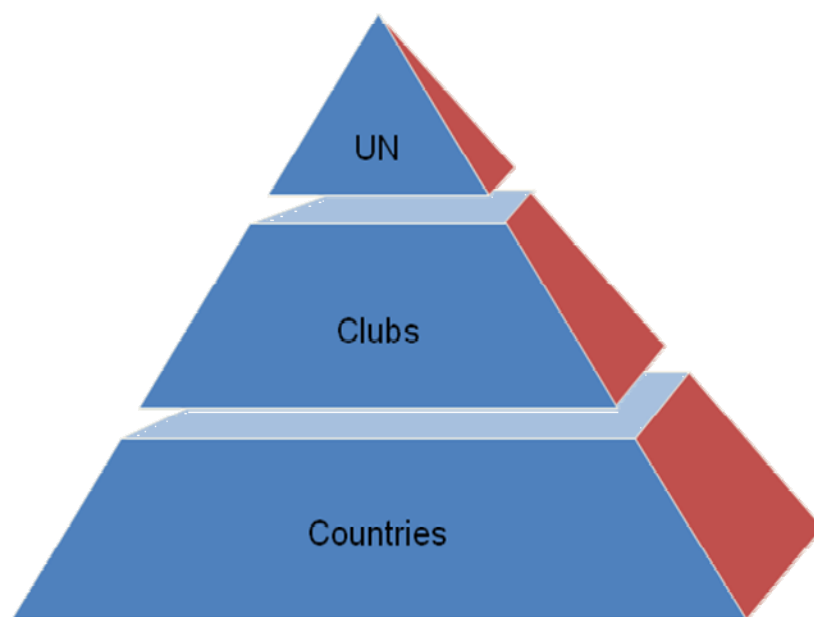
4. Post-2012 Climate Architecture: A Feasible Multi-Stage Hybrid

Structure with GDRs as a global allocation system

General Framework: Big Picture

In this paper, we propose a multi-stage post-2012 climate architecture with both a top-down climate international organization to determine short-term climate targets, overall target allocation, negotiation time table, and a bottom-up country-to-country bilateral, and multi-lateral negotiation framework for feasible political negotiation and actual enforcement. The overall political enforcement structure can be decomposed into three levels: global (as United Nations), regional (such as country Club taking collective actions) and single country level.

FIGURE 2: A TOP-DOWN AND BOTTOM-UP POST-2012 CLIMATE POLICY ENFORCEMENT FRAMEWORK



Top level – A Global Climate Agency

Ideally, a feasible post-2012 climate agenda would have a top-down international institution to determine the targets and timetables aspect of the climate change negotiating process, in particularly incorporating the most recent scientific findings and abatement technology innovations. The UNFCCC is a good start, but its role may need to strengthen after 2012, to integrate the long-term objective with the short-term objectives to fit our proposed multi-stage framework. IMF and World Bank are two good examples to initiate such a global climate agency shaped by a formal international panel. This top-down international organization needs to decide the global carbon abatement and concentration targets, and distribute burdens and timetables across various country

groups (defined as “clubs” in this paper, which we elaborate later), such as high income countries, upper or lower middle income countries, low income countries, i.e. to further divide the current Annex I and non-Annex I categories in the Kyoto Protocol and FCCC. The existence of the institute is also useful to help negotiate climate agreements among top-emitter countries such as the United States and China, or even alternatively smaller geographic groups. In summary, a global international organization will offer a simpler negotiation process and focus on groups of countries (clubs) and key emitters that will make the climate action agenda more effective. As for adaptation and technology transfer, a global institution like the UNFCCC can also help to build a climate change trust fund to promote adaptation and facilitate technology transfer among clubs. We leave the clubs at the second level to be more flexible to the need of specific groups of countries. Also with different cross-country or multi-lateral negotiations, the club composition may also change through the years.

A top-down burden sharing for each club and overall projects can be reviewed and assessed every five years. This is similar to the burden-sharing suggestion raised by Frankel (2007), and also consistent to the graduation and deepening framework suggested by Michaelowa (2007). We need to note that, although some developed countries need to bear more burden today, as time passes by, developing countries’ total emissions would exceed those of developed countries, thus with the increasing capacity the developing countries’ burden share will increase, meanwhile developed countries’ share will decline in the future.

Club Level

Once the long-term desired emissions and concentration carbon targets are determined, countries can shape climate clubs in a bottom-up manner, such as G8, EU, or maybe a developing country club in the future. The organization of the countries needs to consider the following factors:

1. **Geography:** For example, there could be a European Club, a Northeast Asia Club, an Arabian Club, etc. The reason is that countries in the same region usually share similar political systems, history and status quo, so it’s easier for them to reach consensus in the regional negotiation.
2. **Development Level:** For example, there could be a High-income Club, a Low-income Club, etc. The reason is that countries at similar development levels usually face the same environmental problems and have similar capabilities and responsibilities. So a club organization based on development level can fit into our suggested multi-stage climate framework very well. Developing countries can have a very different time-table that lets them develop first with voluntary carbon abatement, and then at a later stage to achieve moderate or even more stringent binding commitments.
3. **Different Economic or Fiscal System:** Clubs could be classified by economic system and domestic fiscal system, for example, market economies and planned

economies, or countries with emission trading system and countries with carbon tax system. For practical concern, it is easier for the countries with similar economic and fiscal systems to bind together, to decide whether they will take a unified carbon trading market, or a harmonized regional carbon tax regime, or a hybrid system with safety valves. Then between clubs, various market-based programs can be sewn together, cap-and-trade can be linked with CDM and other emission-reduction-credit systems, emission permits can be traded against carbon tax obligations, absolute binding caps can be linked to intensity based trading programs (Pizer, 2007; Hall, Levi, Pizer and Ueno, 2008; Jaffe and Stavins, 2008).

4. **Other factors:** Bigger carbon emission countries like US, China are important players in the climate change arena, together emitting about 45% of carbon emissions. Thus, a China-US joint economic dialogue on climate change may provide more opportunities to build a long-term collaborative relationship on carbon emission reductions. In fact, large carbon emitter countries such as China and US can shape its own club, and negotiate with other clubs.

To have a club institutional setting, we expect it might be feasible to rely on the existing groups of countries, such as the EU, G77 and China, and others, to support either a regional emission trading regime, or a regional harmonized carbon tax regime. The overall obligations for each club can be determined based on our proposed GDR calculations, such as our calculation for high, middle and low income countries, and EU. Also by dividing and organizing countries into clubs, it is easier to coordinate different countries at different stages.

The bargaining problem associated with technology transfer has long been a barrier to progress and consensus in dealing with environmental problems. The disputes usually focus on intellectual property rights (IPR) and historical responsibility. Developed countries' governments argue that because they are democratic and the IPRs belong to private companies, there is no power for them to decide the transfer of technology. However, within the framework of policy clubs, it is easier to have technology transfer protocols between different clubs. Within each club, policies can be designed to let countries share the carbon abatement or adaptation technologies without any further costs. At the club level, new technologies can be obtained through the proposed global climate change trust fund, or with the exchange of carbon credits, or R&D collaborations inside of a club.

Country Level or Within-Country

With the multi-stage climate framework and hybrid global-club-country political structure, each country can set up its own climate agencies either under the environment ministry or energy bureau or an independent bureau, to make its own sustainable development goals and plans which are supposed to be consistent with their negotiated obligations. These can address technology transfer, R&D funds, market based instrument design, and enforcement regimes within a club. Each club can apply GDR to allocate obligations

within club, and even for a single country, the same methodology can be applied easily to allocate obligations for different provinces, states, or regions as well, or to modify the income tax system consistent with climate change mitigation efforts.

In Summary: Advantages and Challenges

Compared to other post-2012 climate policy proposals, our proposal aims to engage developing countries in carbon abatement and while safeguarding their right to development. In addition, our proposal intends to preserve market-based instruments such as emission trading, carbon tax, CDM and other flexible instruments suggested by the Kyoto Protocol, but need to deepen the targets and efforts in its post-2012 era for Annex I countries. To achieve this, we propose a multi-stage framework to gradually involve the developing countries, and further extend the broad categories of Annex I and non-Annex I into more categories based on their geography, development levels, carbon policies and country specifics. Such a multi-stage hybrid system is very likely to work well with the proposed global allocation principle – GDRs at club and country level, by reconciling human development and climate protection. Therefore, the main advantages of this framework can be summarized as: 1) engaging more countries to join the carbon mitigation action, overcoming the coverage deficiency problem in the Kyoto Protocol; 2) The multi-stage parallel club system can accommodate country heterogeneity, thus each country can tailor itself to participate into the world GHG mitigation activities; 3) by linking with cap-and-trade, emission reduction credits, and providing moderate or losing target for developing countries, can preserve the cost-effectiveness properties of flexible market-based economic instruments, and improve the global welfare as a whole.

Still, this might be a very ideal hypothetical case, as many pitfalls both politically or economically might jeopardize support for this climate architecture. Currently, both the multi-stage framework and the GDR calculation may still be outside the main spectrum of proposals which focus more on cap and trade, harmonized carbon tax and technology protocols. However, without a clear and binding target and acceptable burden-sharing rules, cap and trade, or regional carbon tax regime cannot address the increasing carbon leakage problems even though small scale CDM or VER can be applied in non-Annex I countries, so that the overall target toward stabilizing climate might fail. Different instruments, cap and trade, hybrid safety valves, harmonized tax, CDM and etc, all need to fit into a common but differentiated framework at the global coverage. Voluntary actions without engaging most of the developing countries will also not work at all. Therefore, we propose such a potentially successful climate regime, hoping this can serve as a useful platform for all the other post-2012 climate policies.

Therefore, currently the biggest challenges are how to link the climate action time-table, multi-stage and hybrid architecture with the real negotiation process, to illuminate the structure of the necessary solution and get more political acceptance from both developed and developing countries. And the second challenge would be the punishment policy for countries which deviate from the negotiation. A successful climate architecture

is expected to be a self-enforcing regime. So if one country deviates, the other countries in one club need to bear more obligations to fulfill the club target, thus with the monitoring and trade sanction threat, such a framework might work best in practice.

5. The Role of Developing Countries: Opportunities and Challenges

Facing the future climate catastrophe, it is urgent and necessary to get developing countries on board to break the negotiation impasse and reverse the trend toward climate damages. Even if currently all the developed countries reduce their emissions at their best effort, most of the developing countries are following the old pattern toward energy-intensive production with dramatic increases in the per capita use of fossil fuel energy. So the developed countries' reductions might not be enough to offset the increase in developing countries' GHG emissions. Obviously, developed countries played the key role in the pre-2012 era, and in the post-2012 era developing countries will gradually play a more important role in this battle to mitigate the climate crisis.

Currently, a feasible post-2012 climate architecture is under hot debate by most developed countries. However, voices of scholars in the developing countries are hardly heard in the mainstream of the discussion. We believe this will change over time, when developing countries' governments and scholars realize that, more active engagement and leadership are necessary to play an important role in these political negotiations. Although climate change is a crisis for all of humanity, if under a feasible and fair climate regime, climate change also presents both challenges and opportunities for developing countries. In order to harness these opportunities, our proposed multi-stage hybrid framework with a revised GDR burden-sharing rule is a very flexible mechanism for many developing countries. Here we use China as an example to elaborate the future potential opportunities and challenges. India is growing at a similar rate as China, and also tends to follow the increases in the energy and carbon intensity development path, so our case below might also shed some light for them as well.

Case of China: Current Situation

China's boom has lasted for thirty years. GDP growth rate is 9.6% on average in 1979-2006, and 11.4% in 2007. China's GDP was \$3.4 trillion in 2007, which is more than 12 times higher than in 1980. Besides the fast increase of GDP, current trade flow is \$2.17 trillion, which is more than one hundred times larger than in 1980. With the increase in wealth, poverty in China decreases by a large amount. According to *China Development Report 2007* compiled by China Development Research Foundation, from 1981 to 2004 the poverty rate of China has been sharply declined from 64% to 10% (NBS, 2007).

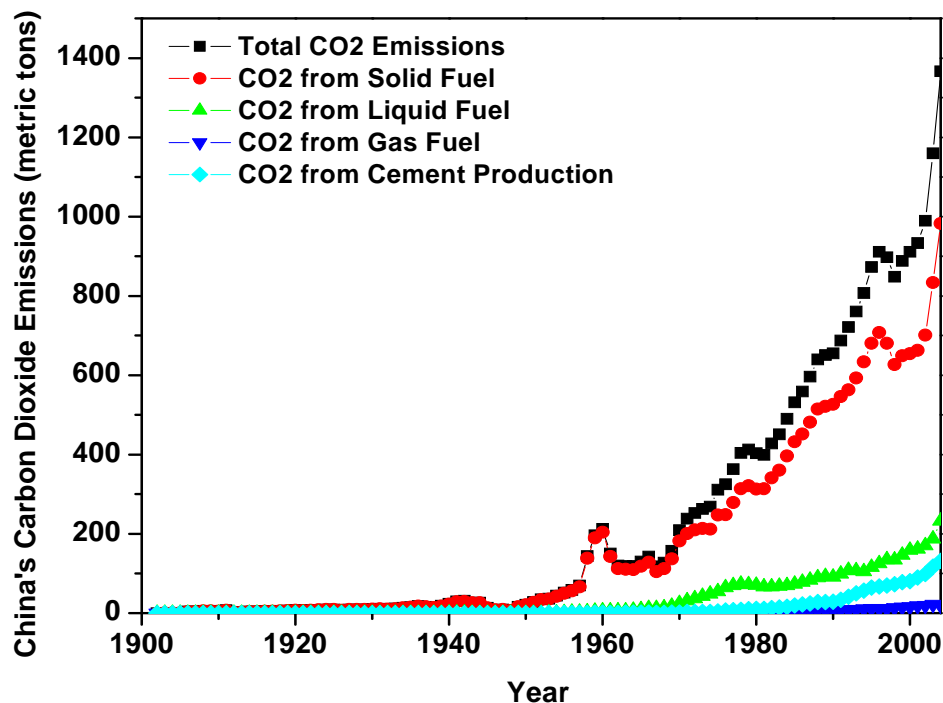
However, with the tremendous economic success, China's environment has severely deteriorated sharply in the last decade. Carbon dioxide emissions rocketed to 1366 million metric tons in 2004, which is about 3.4 times higher than in 1980, and about 80% since 1990⁷ (figure 3). The Netherlands Environmental Assessment Agency has similar

⁷ Data Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory.

number for China's carbon emission in 2004, and estimates China's 2007 emission at about 1833 million metric tons based on trends in BP energy data for consumption of coal, oil products and natural gas⁸. It is also foreseen that China will continue the trend in the future and the emissions. Auffhammer and Carson (2008) use China's provincial information, forecasting that China's carbon emission growth is about 11% for 2004-2010, exceeding its GDP growth rate.

Carbon emissions from coal account for more than 70% of total carbon emissions in China, and in recently years its growth rate has exceeded the GDP growth, mainly due to the boom in the electricity sector. Carbon emissions from cement and oil use also have increased dramatically in recent years due to the growth in transportation and the real estate market.

FIGURE 3: CHINA'S CARBON EMISSIONS



Data Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory.

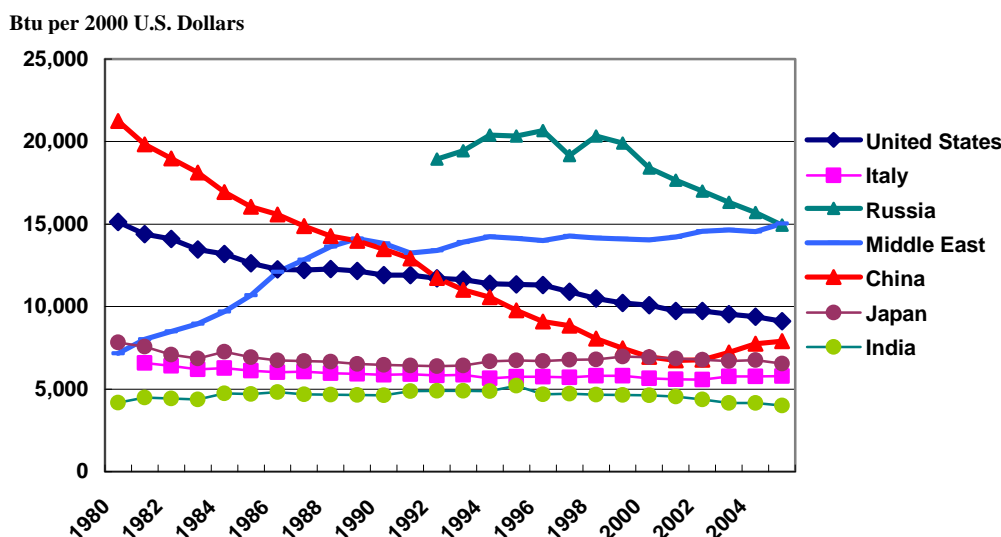
The Chinese government has already imposed several policies to counteract this trend. However, most of the approaches are not driven by interests in carbon emission reduction, but driven by its domestic environmental pressures, energy security, and resource conservation concerns. Two major policies were adopted in China's 11th Five Year Plan.

Energy Intensity Target in 2010: The Chinese government has set several goals in its 11th Five year plan, one of which is to reduce the energy intensity of the economy by

⁸ <http://www.mnp.nl/en/publications/2008/GlobalCO2emissionsthrough2007.html>; raw data is from IEA (2007)

20% in 2010 compared to the 2005 baseline. Further detailed targets are allocated at the provincial and individual sector levels as well. The more prominent action is to shutdown many inefficient power and industrial plants and the promotion of end-use energy efficiency. To enforce this policy more effectively, the evaluation of local officials' performance has been linked with the local energy reduction target as well. Figure 4 shows China's energy intensity trend from 1980-2006; the overall trend of energy intensity is going down. Though from 2002 to 2005 the energy intensity increased⁹, after China implemented energy saving regulation under the 11th Five year Plan target, China has achieved significant compliance effects. Compared to 2005 baseline, China's energy intensity decline for 3.83% in 2006 and a very significant cut of 11.4% in 2007¹⁰. When compared to other countries, China's total energy intensity (PPP adjusted, including primary energy use in both manufacturing and residential) also improves substantially, currently even lower than US and Russia, and convergent to the Japan level.

Figure 4: ENERGY INTENSITY: COMPARE WITH OTHER COUNTRIES



Source: International Energy Annual 2005 Data, posted June-October 2007
<http://www.eia.doe.gov/iea/>

Renewable Energy Promotion:

The Chinese government has set a target to increase primary energy from renewable sources from 7% of 2008 to 16% in 2020. A few incentive schemes have been initiated, such as feed-in tariffs, renewable portfolio standards, as well as a renewable energy development fund. The renewable energy promotion law also came into effect on January 1st, 2006¹¹.

It is very important for developing countries to recognize the importance of their future

⁹ China Statistical Yearbook, and China Energy Yearbook, various year.

¹⁰ Author's own calculation based on the total energy use and constant price GDP data in Chinese Statistical Yearbook (2008)

¹¹ http://www.gov.cn/ziliao/flfg/2005-06/21/content_8275.htm

role in responding to the changing climate, and take actions through appropriate institutional, technical, economical and policy measures. The current ongoing climate negotiations are now in a political impasse, but they pose a great opportunity for large developing countries like China, to take the lead between the north and south, to help design the post-2012 climate architecture. First, it is important to emphasize the development need of the south, give priority to domestic sustainable development which is consistent with climate change mitigation as well. Second, a gradual time table would be more realistic for developing countries: from no commitment, to voluntary contributions, to moderate targets, and eventually to binding and more stringent targets. Note, eventually when the developing countries catching and their per capita incomes converge to the world average level, it is also fair to take on more stringent targets and commitments. Finally, developing countries are the most vulnerable to the negative impacts of climate catastrophe. Thus it is also helpful to involve in either the regional clubs or collaborate with the developed countries, to improve their capacity for climate change adaptation and promote technology transfer through the support of the climate trust fund.

As the largest carbon emitter in the world, China has realized that climate change is a challenge that the Chinese government has to cope with from both the domestic sustainable development need and global political perspective. China has already played an important role in the global CDM market. For the post-2012 political negotiation on climate change, we are confident that with appropriate policy and global institutional design, developing countries, in particular, China could benefit from this global climate program. The following elements are important for China to achieve the developing country leadership on carbon abatement, reconcile GHG mitigation with domestic sustainable development, facilitate technology transfer and R&D on climate mitigation and adaptations.

- The political regime is the key element for coping with climate change at both a global and national level. Actively involving in the post-2012 climate policy negotiation, and taking the leadership role of developing countries, may bring more opportunities than obstacles for future development. For example, China can play an important role in determining time tables, or organizing a developing country club, negotiating for the “survival income” or “survival emission” threshold, and identifying specifics on climate trust fund for technology transfer etc. In addition, at the national level, it has been noted that central government objectives sometimes are not aligned well with local governments, so if the local government still places economic growth over energy saving and carbon mitigation, the target will still be difficult to achieve. A new official evaluation system to bring both local environmental and climate change policies into account will bring positive outcomes.
- Reconciling both local pollution and climate change concerns may bring large co-benefits at local or regional levels. Currently some environmental policies targeting local pollutants such as TSP and SO₂, can bring substantial climate

co-benefits. Local environmental taxation and energy conservation standard policies can easily be revised to take into account climate change mitigation. A good “co-control” policy might be firstly removing energy subsidy and let the market play the role in determining market price; then in addition impose a carbon tax policy, which discourages the energy demand on coal, oil and gas, and meanwhile brings substantial “co-benefits”, thus also alleviating China’s climate change political pressure from developed countries (Cao, Ho and Jorgenson, 2008). In terms of the multi-stage hybrid framework proposed here, improving local sustainable development is also helpful to engage more developing countries, and reduce carbon leakages the global level.

- Environmental laws should be implemented strictly in order to ensure effective enforcement. Currently, although many environmental or energy conservation promotion laws have passed, it is difficult for the policy makers to implement in practice for current laws only specify the energy saving or clean energy principles, without specifying actions or concrete policies for immediate actions.
- Climate Change NGOs and their activities are useful to improve public awareness of the climate change crisis, and to educate people to improve their capacity to deal with climate change risks and adaptations. For example, the worldwide network of 400 NGOs “Climate Action Network (CAN)” propose a similar staged proposal by suggesting a route based on per capita emissions, ability, capacity and historical responsibility to determine how countries move from a loosing commitment stage, that is, a greening and adaptation track that reduce emissions and meet sustainable development objective, to the Kyoto track with binding commitments (Höhne *et al.* 2007). To break current climate impasse, and advocate the proposals from developing country perspectives, many climate change NGOs may play important complementary roles in addition to the government efforts.
- It would be in the interest of developing countries to extend the scope of current CDM projects by taking into account the technology transfer element (Teng, 2008), and enhance domestic learning by doing capacities. Developing countries can voluntary reduce carbon emissions besides CDM, and may use these credits to trade with developed countries, thereby gradually moving from CDM only, to voluntary reduction and trading, and finally binding targets after exceeding a certain development threshold.
- Adaptation should be seen as part of the local sustainable development and strategies to alleviate poverty. Within the developing country club, centers providing funds and adaptation strategies and technology support, should be established in particular in south-east Asia and Africa.
- R&D and technology development are the key solution for humanity to reverse the climate trend. In order to encourage collaborations within and across clubs, the

formation of clean energy research centers at both local, regional and global levels should be considered. UN-related agencies can negotiate the overall research funding to stimulate the investment in energy research and technologies.

- To bring more developing countries on board through our proposed climate framework, a climate fund for other resources should be established to support voluntary climate mitigation activities in developing countries, and help them to cope with emerging climate change risks.

6. Conclusion

Climate change is one of humanity's most urgent and difficult challenges. Scientific research has already indicated the economic costs of unchecked global warming will be very severe. Without the engagement of vast developing countries, in particular China, even all the Annex I countries fulfilling their Kyoto commitments and deepening their mitigation efforts in the post-2012 era, the world will still experience rapid global warming. Thus, a feasible, flexible, accessible and agreeable post-2012 climate policy framework would be the key to solve the future climate crisis.

This paper provides a new multi-stage climate policy framework based on a revised Global Development Right (GDR) framework, and propose a feasible hybrid negotiation framework to integrate a top-down level global climate agency and a bottom-up country club organization. This proposal is still at a very crude stage, however, it might be a way to break the current north-south climate political impasse and engage developing countries to gradually move from their current positions of no commitments to finally binding commitments, and safeguard their priority for development needs.

Our Goal is trying to formulate a potentially agreeable international negotiation framework on climate change, according to the UNFCCC principle "common but differentiated responsibilities and respective capabilities and their social and economic conditions", to engaging countries at different stage and different negotiation process. Our proposal starts with a clear and easy acceptable burden-sharing principle, by balancing equity and efficiency, capacity and responsibility through a global development right (GDR) framework. Such an individual-based framework can easily incorporate development thresholds for either income or emission based, conduct sensitivity analysis on specified capacity and responsibility share parameters, and take countries' dynamic economic development into account. In this paper, we revised Baer, Athanasiou and Kartha (2007) GDR calculation by extending the historical emissions back to 1850, and also consider the land-use carbon sink as well. In addition, a crude projection for 2020 is also presented for major countries and clubs.

Finally, we also emphasize that, launching an effective climate regime for containing climate change provides an opportunity for developing countries. Further, we use China – the world's biggest carbon emitter and largest developing countries – as our case, to

elaborate the key elements for China to address climate change challenges as opportunities, by revising its own political regime, reconciling local sustainable development and climate mitigation, encouraging R&D and cross-country technology transfer, encouraging climate NGOs, enhancing capacities for future expanded CDM market and adaptation for global warming, and eventually bringing other developing nations together by establishing a fair and efficient post-2012 climate architecture.

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