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Differentiating (historic) responsibilities for climate change : exploring the case of China

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Differentiating (Historic) Responsibilities for Climate Change: Exploring The Case of China

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Abstract

Following the conclusion of the official work of the Ad hoc group for the modelling and assessment of contributions of climate change (MATCH), this paper takes a look on the politically more sensitive aspect of the Brazilian Proposal, namely the issue of differentiating (historic) responsibility for, and not merely (causal) contribution to climate change. Its aim is (i) to highlight the fact that, while related, the two issues ('contribution to' and 'responsibility for') are fundamentally different and should not be confused, (ii) to propose a methodology of calculating shares of responsibilities as opposed to the shares in causal contribution arrived at in the MATCH results, and (iii) apply these conceptions in depth in the case of China. Two conceptions of responsibility ('strict' or 'limited') are applied to operationalise the notion of 'respective capabilities' given in Article 3.1 of the UNFCCC. The key message resulting from the calculations is that causal contribution – while an important indicator of (environmental) relevance to the problem – must not be confused with moral responsibility for it. The rather large difference between the responsibilities at the two extremes of the scale under both conceptions does give pause for thought as to what sorts of burdens can justly be demanded in any application of the UNFCCC principle of common but differentiated responsibilities, whether in the context of the Brazilian proposal or beyond.

We apply these conceptions of responsibility to the case of China and discuss how they can inform the discussions over future commitments under a Copenhagen agreement.

1. Introduction

Climate change is increasingly acknowledged to have strong ethical dimensions, and global solutions are unlikely to be crafted, or stable, without some broad conception of what would be fair (IPCC 1996, Stern 2006). There is a burgeoning literature on these dimensions (Gardiner 2004, Brown et al. 2006, Klinsky & Dowlatabadi 2009). Some recent work has focussed on a particular dimension, namely that of historical responsibility. Early on, the work of the *ad-hoc group for the modelling and assessment of contributions of climate change* (MATCH) that was motivated by the Brazilian proposal (UNFCCC 1997) concentrated on the causal attribution of historical greenhouse gas (GHG) emissions to countries (Höhne & Ullrich 2003, den Elzen et al. 2005a).

It had been criticised that the past work on historical contributions for climate change, by focussing on the technical, natural science aspects, neglected the ethical and interpretational aspects. While the MATCH work avoids the ethical dimensions of historical responsibilities, some new publications carefully approach the challenge to distinguish causal contribution to climate change from historical responsibility for climate change (Botzen et al. 2008). Discussions of the earlier work showed a clear demand for a deeper analysis of these normative and moral aspects (Botzen et al. 2008). In an earlier paper (Müller et al. 2009) we respond to this demand. The present paper is based largely on this previous work, but gives particular attention to the role of China.

Following the Brazilian proposal, the notion of historical responsibility for climate change of Annex I parties has been regularly evoked by many developing country parties. It is one of the main lines of arguments underlying the principle of common, but differentiated

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responsibilities in the UNFCCC or the polluter pays principle more generally. The discussion on equity – i.e. a political economic approach to historical responsibility (Friman 2007) – has been widely present in the Chinese debate on climate change. It is indeed one of the main discursive elements in China (Ellermann & Mayer 2009), thus framing the understanding of the country's ethical position vis-à-vis developed countries and the rest of the world. This paper therefore turns the issue from a scientific into a moral question concerning the interpretation of the results of the MATCH group, and focuses on the position of China.

2. The Conceptual Framework

2.1. Contribution Versus Responsibility

Climate impacts – be they anthropogenic, due to natural variability or anything else – will inevitably have a large multitude of causes, each causally contributing to the impacts in question. The (moral) responsibility for climate impacts will also typically be shared by a number of actors. The key difference between being morally (partly) responsible for, and (causally) contributing to is that the former is a blameable matter which only makes sense if the impacts are anthropogenic, while the latter is not. The 1628BC eruption on the Aegean island of Thera (Santorini), it has been argued, led to an average global cooling of 1.5°C over the following one hundred years, and consequently to the downfall of the Minoan civilization, but it would be considered odd to hold the mountain morally responsible.

The problem is that in the case of anthropogenic impacts, the difference, while remaining, is sometimes not quite as self-evident. There is a link between a moral agent causally contributing to an impact and being morally (partly) responsible for it, but that does not mean that the two are the same. Their difference becomes clear when considering that they generally imply different shares.

The MATCH project modelling has focussed on determining the causal contribution of time series of greenhouse gases covered under the UNFCCC to certain climatic impacts, in particular to changes in mean global temperature. The lesson has been that one really cannot speak of causal contributions to climate change per se, at least not if one is intent on specifying numerical shares thereof.

The advantage of focussing on the effects of emission time series on certain climate parameters was the purely scientific nature of the exercise, which was meant to safeguard the discussions from being dragged into normative or even moral debates. Even in the context of establishing shares in causal contribution, normative issues could not be completely avoided. One of the key normative decisions was the way in which emission time series were associated with particular countries. It is one thing to say that this and that series of emissions has contributed a certain percentage to the increase in global mean temperature over the 20th Century, and quite another to say that the United States of America have done so. The former is purely scientific; the latter involves a normative decision of how to identify 'the emissions of the US' (at a given time). The implicit assumption of the MATCH team was that (a) the (anthropogenic) emissions associated with a country for a given period are those emitted over its sovereign territory, and (b) the sovereign territory is changing over time.

There are a number of problems with this traditional conception, not least that it does not lend itself easily to accommodate 'bunker fuel' emissions from international travel and transport. Another, lesser known problem with this sort of traditional sovereignty based definition is that it does not lend itself to take account of joint contributions and responsibilities, short of pooling the sovereignty of the territories in question. This shortcoming shall be discussed briefly in the context of Article 4 of the UNFCCC, which can be interpreted as implying joint North-South responsibility over the (increments in) emissions in developing countries since the Convention was signed in 1992. For the rest of the article, the traditional sovereign territory definition of countries' 'anthropogenic' emissions shall be followed however, both for determining their relevant causal contributions and moral responsibilities.

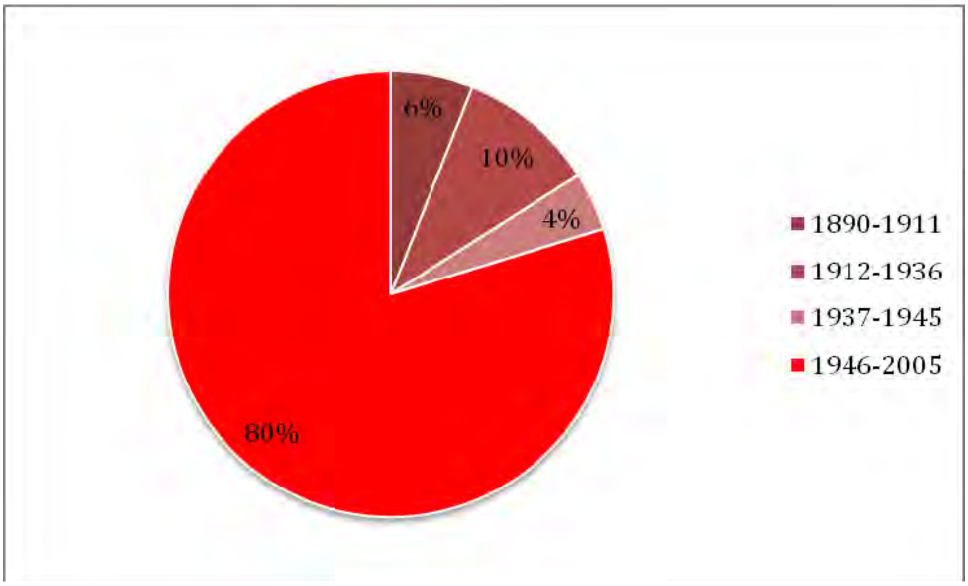

Figure 1. China's emissions of greenhouse gasses during different historical periods.

The normative issue of identifying the sovereign emissions of China is not completely straightforward. During the observation period from 1890 to 2005 several changes occurred in what is now the sovereign territory of the People's Republic of China. We have to rely on the decisions regarding the attribution of the emissions made by the MATCH team that included Chinese scientists and reflect these here. The data recorded for China during this period is largely dominated by emissions from fossil fuel combustion as recorded in Marland et al. (2005) and thus follows their definition of "mainland China".

Figure 1 displays the shares of emission contributions made to total emissions during different historical periods. Until 1911 China was under the rule of the Qing Dynasty and during parts of this time period, small parts of the country were occupied by foreign powers. There was however no major colonial rule over China that would warrant a deeper discussion of the attribution of emissions during that time, which amount to 6% of total emissions between 1890 and 2005. 1912 to 1937 saw major domestic conflict with warlords fighting over regional rule in the Republic of China, but there should be little question over the attribution of emissions during this time, which amount to 10%. Contrary to this, major parts of China were occupied by Japan between 1937 and 1945. Marland attributes these emissions to China, mirroring similar decisions like the attribution of pre-independence emissions over Indian territory to India and not to Great Britain. In spite of the regionally rapid industrialisation and deforestation during this time, the share of these 9 years amounts to only 4% of total Chinese emissions. From 1946 on, sovereign rule over mainland China became again clearly Chinese, and this historical period contributed 80% of the emissions from 1890 to 2005. Emissions in Taiwan, Hong Kong and Macao are not included in the China dataset.

While the question of Chinese sovereign emissions is not absolutely straightforward, the contribution shares during historical periods that could be contentious (1890 to 1911 and 1937 to 1945) make up merely 10% of total Chinese emissions. In practice, the relevance of the normative decisions surrounding this issue is therefore limited.[3]

[3] They nevertheless certainly have to be noted in an ethical paper on Chinese historical emissions.

2.2. Types of Responsibility: a Loosely Aristotelian Framework

To be responsible for something harmful is to be worthy of blame for it.[4] Aristotle contends that *blame* and praise are bestowed on *voluntary* actions, while *involuntary* ones are *pardoned*. The key to responsibility for actions is thus their voluntary status, for which he gives two necessary conditions:

> "First, there is a **control condition**: the action or trait must have its origin in the agent. That is, it must be up to the agent whether to perform that action or possess the trait — it cannot be compelled externally.
>
> Second, Aristotle proposes an **epistemic condition**: the agent must be aware of what it is she is doing or bringing about"[5]

However, ignorance *per se* seems to be slightly too easy for pardoning, which is why the condition is usually strengthened insofar as the agent *could have reasonably been expected to know*.

Aristotle's conception of 'responsibility' is based in his theory of virtue, which concerns 'passions and actions.' But there are other theories which see the concept rather in the context of duties, in particular in derelictions of duty, which are not (necessarily) actions but equally liable to give rise to blame. Figure 1 is an attempt at representing the interplay between the distinctions of voluntary/involuntary, harmful/harmless, agency-/duty-based, and the type/level of blameworthiness (responsibility) attached to their combinations.

Aristotle's conditions on assigning blame to actions (and, *eo ipso* agents) are about whether they are carried out voluntarily or involuntarily. However, as illustrated in Figure 1, blame can also be assigned or withheld regardless of this distinction. If, for example, the effects of an action are *harmless* (category I), then clearly no blame should be attached to it, even if it was voluntary. Moreover, there are situations where, contrary to Aristotle conditions, 'strict' blame (responsibility) is handed out simply on the ground that the effects are harmful, regardless of whether the harm was done voluntarily or involuntarily (category III.b).

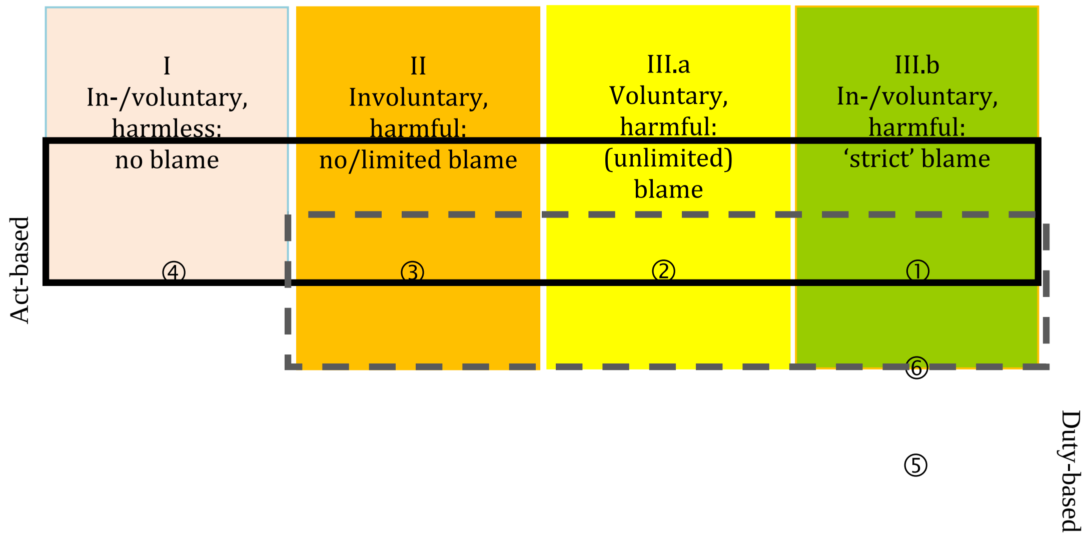

Figure 2. Categories of blame/responsibility.

Act-based blame. In the context of climate change, blame/responsibility is usually seen as applying to certain acts, namely the emission of greenhouse gases – i.e. it is act-based. For example, if someone drives a car, and if the emissions resulting from this act are deemed to be harmful, then they may be judged to deserve unreserved blame just because the emissions are harmful (strict blame, ① in Fig. 1), or because they drove voluntarily, in the

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[4] Strictly speaking it is either blame- or praiseworthy, but in the present context the former suffices.

[5] Eshleman A (2004) Moral Responsibility. In: Stanford Encyclopaedia of Philosophy. Stanford University. See also Aristotle (1908) Nicomachean Ethics, Vol. Clarendon Press, Oxford: III.1-5, 1110a-1111b4.

full knowledge of the harmfulness of the emission and without coercion (unlimited blame, ②). If, however, they can plead reasonable ignorance or coercion, then they may get a (limited) pardon (no/limited blame, ③). Finally, if the emissions in question are classified as harmless, then no-one can justly be blamed (no blame, ④).

Duty-based blame. What is not usual is to consider blaming someone for certain harmful emissions not because they were actively engaged in emitting, but because they had duty to prevent them. Thus if two individuals, say Jane and John, enter a contract that Jane is to reduce her emissions and that John is to bear her additional costs, then it can be argued they both have a joint-duty to reduce Jane's emissions, and that if the reduction does not occur, that they could be jointly blamed. The blame may, of course, not lie equally. Jane may have wished to reduce but did not receive the money to do so, or John may have wished to pay for Jane's emission reduction, but Jane having no inclination to do so. The point being that John might have to take responsibility for a certain amount of emissions, even though they were not actually emitted by himself (⑤), while Jane may not have to take responsibility for the whole of the emission increment she failed to reduce, because there was a joint dereliction of duty (⑥).

3. Differentiating Contributions and Responsibilities

3.1. Methodologies

3.1.1. Causal Contribution Shares: The MATCH Methodology

The methodology of the MATCH project was designed to establish the relative causal contributions by countries to changes in global average temperature. The MATCH percentage figures for countries' shares in contributing to these changes are determined by the anthropogenic emissions that have historically been emitted from their sovereign territory. These percentage shares are themselves relative to the type of impact chosen, and they depend on the sequential order of the emission series in question. However, to simplify the calculations, it is possible to use the sum of the historic emissions – or rather their relative size – as a reasonable approximation for the purpose of this paper for their relative causal contributions (den Elzen et al. 2005b, Hope 2008). Instead of using the MATCH project modelling techniques, the aggregate historic country emissions – using the 1995 Global Warming Potentials (GWPs) for different gases as used under the Kyoto Protocol – emitted between 1890 and the present (2005) are simply used here as determinants of the contribution as well as responsibility shares in question. The proportion between countries' historic emissions since 1890 is used as a proxy measure of the relative size of their contribution to climate change impacts.[6]

3.1.2. Responsibility Shares: The Allowance-Based Methodology

The issue of how to measure and compare responsibilities has been controversial for some time, not least with respect to comparisons between the 'large emitters,' such as the US and China. In a recent newspaper article, the IEA chief economist was reported to predict that

[6] We would like to emphasise, however, that our methodologies could easily be adapted to be used with the full MATCH modelling techniques. We need to note that using GWP factors can only be considered an approximation, as over the long time spans considered here, static factors ignore the feedbacks and long term changes in global warming potentials. While the radiative impact of additional emissions declines with increasing concentration in the atmosphere, the damaging impacts of climate change increase non-linearly. This leads Hope (2008) to the conclusion that marginal damages of a unit of emission are to a reasonable approximation independent of concentration, which allows us to use aggregate contributions to GHG emissions to form causal contribution shares.

"China may overtake the United States as the world's biggest source of greenhouse gases within months", however, he also "accepted that on a per capita basis, people in rich countries still emit far more than individual people in China. […] Historically, China has also contributed little to the present build-up of greenhouse gas emissions in the atmosphere." (Vidal 2007)

The problem with either aggregate (i.e. country-wide) or per capita emissions measures is that, while they may capture some facet of the relevant notion of 'responsibility,' they both fail in capturing others. The percentage shares derived from the aggregate figures clearly capture the causal contribution aspect of responsibilities, but they cannot, by definition, reflect other potentially relevant country aspects, such as population size. Per capita emission figures, on the other hand, do reflect population size, but they are unable to reflect causal contributions, with the effect of assigning the same responsibility to both China and Latvia with 0.8tC/cap, but a 500-fold difference in aggregate emissions. (WRI 2009)

There is no general answer to whether responsibility should be measured in absolute (single parameter) or in relative (multi parameter) terms. There are cases of emission-based responsibilities, which should be quantified in absolute terms, i.e. in terms involving only one parameter, namely physical emissions. In other cases, it may be necessary to relativise these figures in terms of other relevant parameters, such as population sizes – when talking about group/country responsibilities – or wealth/economic production. Traditionally, these relativisations have been operationalised by simple parameter divisions such as the well-known per capita and per unit of economic output (GDP) measures. [7]

Aggregate – i.e. country or regional – responsibility for climate change (impacts), is argued in this paper, *does* need to be relativised in the sense that it has to be measured in multi parameter terms, including – apart from emissions – the size of (certain) populations. However, the traditional operationalisation in per capita terms over-simplifies the situation. Instead a (bottom-up) allowance-based methodology is proposed, which generalises both the traditional absolute and per capita measures.

The idea is that allowances may be allocated to emitters, which they can use against their emissions in calculating their level of responsibility. It is, in general terms, analogous to the system of tax allowances used in most countries in differentiating the tax burden. There can be different kinds of such 'climate change responsibility allowances', depending on the (moral) justification for why they should be allocated. For example, if a certain level of (greenhouse gas) emissions is deemed to be harmless, then one would have to allocate what we call '*basic allowances*' to cover these harmless emissions, on grounds of the fact that no-one should be held responsible (blamed) for a harmless activity.

Other allowances could be allocated on the basis of basic needs, in turn justified by way of the Aristotelian 'control condition' that one cannot be held responsible for what is not in ones control. This kind of allowance has been implemented by looking at '*subsistence allowances,*' based on the assumption that poverty eradication is an over-riding moral aim, and that in present circumstances it can only be achieved through activities which generate a certain amount of emissions. There may, of course, be other (basic) needs-based allowances, which might have to be considered, such as the need to keep the ambient temperatures within certain boundaries in order to survive. The Aristotelian epistemic condition that one should not be held responsible for actions which one could not have reasonably been expected to

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[7] Baer et al. (2007) for example name "cumulative per capita CO_2 emissions from fossil fuel consumption since 1990" as a "reasonable" definition of responsibility. Ultimately however they use country-wide emission contributions adjusted by measures of income distribution in the population to calculate global responsibility shares because it is impossible to express the percentage responsibility of a per capita share (Baer P, Athanasiou T, Karthao S, Christian Aid, Heinrich-Böll-Foundation, EcoEquity (2007) The right to development in a climate constrained world. The Greenhouse Development Rights framework., San Francisco)..

know were harmful – mere ignorance is not sufficient – could also be used to justify the introduction of what might be called ‘epistemic allowances.’ The main difference between these Aristotle-based allowances and the above-mentioned basic kind is that while the latter can be seen as ‘certificates of harmlessness’, the former are merely ‘responsibility wavers’ applied to emissions which would otherwise have been counted as harmful and blameworthy. The main consequences of this is that while basic emissions should be transferable, these ‘responsibility wavers’ should not, and that the latter ought to be used only as ‘back-up’ to the former, should both be issued, and not as complement.

Apart from the question of what sort of allowances should be admitted to be counted against one’s responsibility (for climate change), the key issue with this sort of methodology is, how to allocate those that have been admitted. We believe that in the case of basic and subsistence allowances, a ‘bottom-up’ approach to country allocations – i.e. a definition of country allocations in terms of personal ones – is the most appropriate one. Note that this does not imply that country emissions have to be defined in the same way. In particular, this bottom up approach to allocating basic and subsistence allowances is perfectly compatible with the traditional definition of country emissions as the emissions originating from their sovereign territories.

In the case of epistemic allowances – meant to operationalise Aristotle’s epistemic condition – there is no need to take recourse to such a bottom-up approach to country allocations, particularly if one adheres to the traditional definition of country emissions. All that is necessary, on either the personal or the country level, is to ensure that all the emissions which happened in justifiable ignorance of their harmfulness be covered by allowances.

As concerns personal basic allocations, it can be argued that they should be allocated on an egalitarian principle for the same reasons that support the per capita allocation of global emission permits.[8] The bottom-up methodology then implies that countries can disregard $b \times p_i$ of their emissions in responsibility calculations, where b is the global per capita figure of harmless emissions, and p is the population of country/region i. This illustrates how population figure enters the allocation-based country responsibility measures, and that they are quite different from the traditional per capita measures.[9]

The difference becomes even more marked if some of the other population-related allowances are considered. While there are arguments for a differentiated allocation (in accordance to particular needs) in the case of subsistence allowances, it is clear that if they are equally allocated they would normally not be allocated to the whole population of a country, but only to those who are eligible by living below some poverty line. In other words, it is possible that the allocation of subsistence allowances to a country is dependent on population size, thus generating a (population-) relative responsibility measure. But – unlike in the traditional per capita methodology – the populations in questions are not all inhabitants, but only special needs groups, namely the country’s poor. The proposed allowance-based methodology thus manages to reflect certain population sizes in establishing country/regional climate change responsibilities without the danger of unjustifiably diminishing in-country responsibility differences – by letting the responsible (carbon) rich

[8] Note, however, that the two are *not* the same: to be allocated an emission permit, *per se*, is not tantamount to being given a responsibility allowance for the specified amount of emissions, in the same way in which being given the legal licence to produce tobacco does not give one immunity with respect to the consequences of tobacco use!

[9] For example, if it is agreed that all the emissions in question are harmful, then the basic global per capita allocation $b = 0$ implying that the resulting basic country allocations are equally 0 for all countries regardless of their population size, and thus that the allocation-based responsibility measures are independent of population figures. Per capita measures, by contrast, reflect population size by definition.

hide behind their (carbon) poor compatriots – as can happen in the case of the traditional per capita methodology.

3.2. Data

The calculations made in this article are based on data coming from a variety of sources. The same emissions dataset as in the latest modelling effort of the *ad hoc group for the modelling and assessment of contributions of climate change* is used. It includes 192 countries for three sectors: energy and industry (CO_2, CH_4, N_2O), agriculture/waste (non-CO_2) and land use change and forestry (CO_2) from 1750 to 2100. It is derived with an algorithm that combines emission estimates from various sources in the following hierarchy: National submissions to the UNFCCC published in the GHG emission database (UNFCCC 2007); CO_2 emissions from fuel combustion as published by the International Energy Agency (IEA 2006);[10] emissions from CH_4 and N_2O as estimated by the US Environmental Protection Agency (USEPA 2006); CO_2 emissions from fuel combustion and cement production as published by Marland et al. 2003 as retrieved in 2006 and regional past data of Edgar/Hyde (Klein Goldewijk & Battjes 1995). The emissions of different greenhouse gasses are multiplied by their global warming potential and added up, leading to a single amount of carbon dioxide equivalent emissions.[11]

Future emissions data (i.e. beyond 2005) as used in section 5.4 are derived by multiplying 2005 actual emissions by the average growth rate of six IPCC SRES scenarios for 17 world regions (IPCC 2000).

The source data takes into account changing geographical borders, but only for energy and industrial CO_2. Other gases and sectors are based on current sovereign territory. If a currently existing country did not exist over the whole period, emissions were backward extrapolated based on the country's current sovereign territory.

Historical population data are taken from the HYDE database (Klein Goldewijk 2007) and Penn World Tables (PWT 2006) and, where not available, the World Development Indicators (World Bank 2006).[12] Poverty headcount ratio (as % of population) at $1 and $2 a day and GDP data (PPP current international $) are obtained from the same source for calculating the size of poor populations.[13]

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[10] This dataset was supplemented by process emissions from cement production from Marland G, Boden TA, Andres RJ (2003) Global, Regional, and National Fossil Fuel CO_2 Emissions. In: Carbon Dioxide Information Analysis Center ORNL, U.S. Department of Energy (ed) Trends: A Compendium of Data on Global Change, Oak Ridge, Tennesse., U.S.A. Available online at: http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm. to cover all industrial CO_2 emissions.

[11] See Höhne N, Blum H, Matthews B, Fuglestvedt J, Skeie RB, Kurosawa A, Hu G, Lowe J, Gohar L, Salles ACNd, Ellermann C (forthcoming) Contributions of individual countries' emissions to climate change and their uncertainty , section 2.1 for a detailed description of the emission dataset including issues of completeness and uncertainty.

[12] Because population data for the years 1890 to 1959 are not obtainable for 29 small countries (making up 11 million inhabitants of approximately 3 billion worldwide in 1960), their emission allowances of these 70 years are not counted towards their total share. This leads to very slight increase in the share of LDC+AOSIS in the calculation of responsibility with emissions allowances 1890-2005.

[13] Poverty data of 24 least developed countries was unobtainable. For these countries, the poverty headcount ratios at $1 and $2 a day have been set to a level comparable to that of other LDCs (50% and 75% respectively). The time series of poverty data is not complete for all countries. Poverty shares have therefore been extrapolated for the missing years using existing data.

4. The View From China

4.1 Views From the Literature

Historic responsibility for climate change has been discussed in Chinese publications, but the authors concentrate mainly on direct historic contribution of countries to the main greenhouse gas – that is CO_2 emitted through the use of energy – and unfortunately do not provide information on the source of data (He et al. 2000, Zhao 2007, Xu & Yu 2008). According to these authors, developed countries bear responsibility for climate change as they have emitted 77% of CO_2 emissions from fossil fuel use between 1950 and 2000.[14] He et al. (2000) argue to actively use the notion of developed country historical responsibility to "protect China's interests". To corroborate their point and "refute arguments of 'common responsibility' and the like", they calculate that developing country annual emissions will only surpass Annex I emissions in 2037 and cumulative emissions in 2147.[15]

An analysis that goes beyond directly equating contribution shares to historic responsibility is lacking, and the level of depth largely stops at the Annex I – non-Annex I divide. Chen et al. (1999) however analyse the topic starting with the *Brazilian Proposal* of 1997, its underlying concepts and calculations of contribution to climate change. Comparing current (1990-2010) with historic contribution shares, they conclude that China's interests would not be served if it was singled out from the group of developing countries in analysing historic responsibility for the approach of the *Brazilian Proposal*.[16]

4.2. Official View

As China has put forward a coherent climate policy since 2007, the government's views on the application of historical responsibility and China's position in it have become manifest in various official documents.

> "Both developed and developing countries are obligated to adopt measures to decelerate and adapt to climate change. But the level of their historical responsibilities, level and stage of development, and capabilities and ways of contribution vary. Developed countries should be responsible for their accumulative emissions and current high per-capita emissions, and take the lead in reducing emissions…" (China NDRC 2008)
>
> "According to the principle of 'common but differentiated responsibilities' of the UNFCCC, the Parties included in Annex I to the Convention should take the lead in reducing greenhouse gas emissions. For developing countries with less historical emission and current low per capita emission, their priority is to achieve sustainable development. As a developing country, China will stick to its sustainable development strategy […] and make further contribution to the protection of global climate system. (China NDRC 2007)
>
> "Developed countries shall take responsibility for their historical cumulative emissions and current high per capita emissions to change their unsustainable way of life and to substantially reduce their emissions and, at the same time, to provide financial support and transfer technology to developing countries. […] Given their historical responsibility and development level and based on the principle of equality, developed

[14]This number is in the same range of the MATCH results for the same type of emissions and time period (72.3%). Taking all Kyoto gases into account, the Annex I share for this time period drops to 54%.

[15]According to the MATCH calculations, non-Annex I annual emissions (all gases) have surpassed non-Annex I emissions in 1992 and developing country cumulative emissions (all gases) will have surpassed developed countries by 2024.

[16] "中国一旦脱离广大发展中国家的支持，必将陷于孤军奋战的不利境地。"(Chen et al., 1999).

countries shall reduce their GHG emissions in aggregate by at least 40% below their 1990 levels by 2020 and take corresponding policies, measures and actions." (China NDRC 2009)
"Climate change is primarily caused by developed countries' historical emissions over many years". (China MOFA 2008)

Similar to the Chinese academic views reviewed above, the official line is that firstly, China is a developing country, and secondly, developing countries have little responsibility for climate change. While low per capita emissions are discussed directly for the case of China, in the case of historic responsibility, China is not mentioned individually, but as a member of the group of developing countries with little responsibility overall.

The Chinese position on historic responsibility has become more clearly defined over time. On the outset, China subscribed to a version of the Brazilian position that does not allow for global reduction commitments, but differentiates reduction targets for Annex I countries by historic responsibility only. More recently, China has started to formulate their own position, a *cumulative per capita emissions convergence* approach. This „hard ball" position (Hallding et al. 2009) requires equality of cumulative country emissions divided by the population at the time of the target year – 2100 in the Chinese proposal.[17]

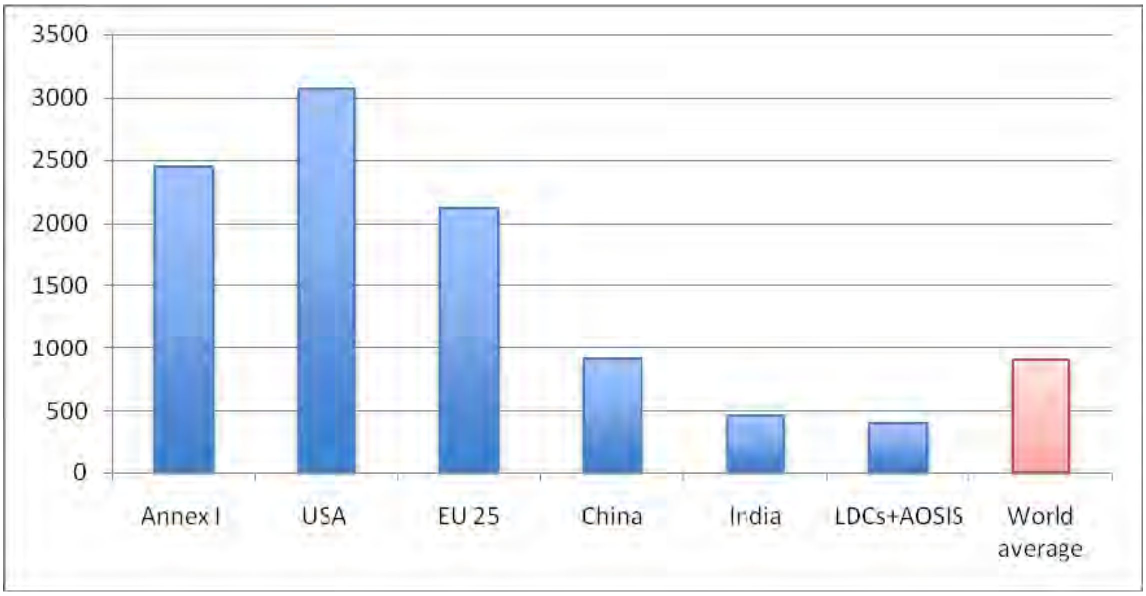

Figure 3. Cumulative per capita (2100) emissions by 2100 according to MATCH data.

5. Results

5.1. Context

Causal contributions were calculated for all countries, but for expository reasons we have chosen to focus on three countries – USA, China and India – and three groups – the group of industrialised countries listed in Annex I of the UN Framework Convention on Climate Change (Annex I), the European Union after the 2004 enlargement (EU25) and the Alliance of Small Island States combined with the Group of Least Developed Countries (AOSIS+LDC, 76 countries). In order to understand the contribution and responsibility figures to be discussed in the following two sections, it is important to appreciate certain

[17] Chinese presentation at the *AWG-LCA Shared Vision workshop* at COP14 in Poznan, 2008. This simplified metric circumvents the problem that there is no logically meaningful expression of average per capita *and* per year emissions. Figure 3 shows this calculation based on MATCH data.

basic economic and demographic facts about these entities, concerning their relative wealth and population sizes.

Figure 4 depicts three non-emission parameters for the year 2005 that are of interest in the subsequent analyses of contribution to and responsibility for climate change by these countries and country groupings, namely their share in global wealth (defined in terms of current GDP (PPP)), in global population, and in global poverty, measured in terms of the number of people living on $1 per day, or below. Not surprisingly, the developed and developing world (Annex I/non-Annex I; North/South) are not the same with respect to these three dimensions: While the 20% of the world population that lives in Annex I countries produces 56% of global wealth, the non-Annex I countries are home to 99.2% of the global very poor. These proportions will have some impact in our responsibility calculations, which is why it is important to keep in mind that they can change considerable depending on the level of poverty one considers. This issue will be re-visited below in the sensitivity analysis section, but just to give an example, and to give an idea of what these shares stand for in absolute terms, consider the fact that China's global share in abject poverty of 12% translates into 129m people, and India's 35% into 377m, while the population of those living below $2 (PPP)/day is 454m in China and a staggering 881m in India.

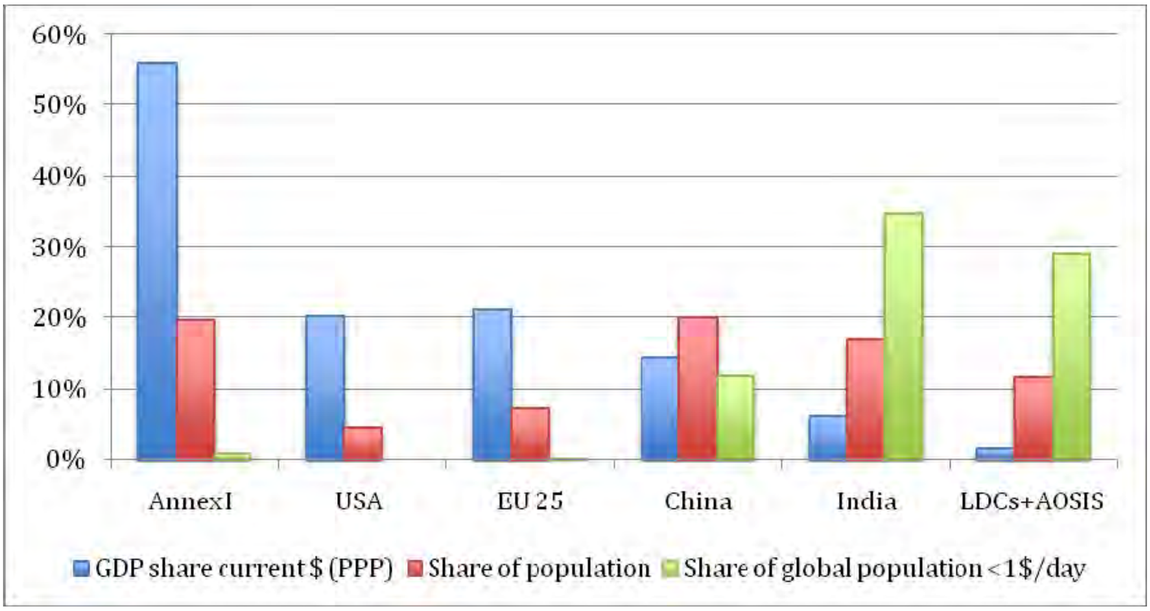

Figure 4. Economic and demographic context (2005).

5.2. Differentiating Causal Contributions

According to the simplified methodology chosen for the purpose of this paper, the share of a country's – or group of countries' – contribution to climate change is given by their share in global historic GWP-weighted greenhouse gas emissions. However, to be able to calculate these shares, some further parameters need to be specified, such as the time frame, the types of emissions, and the countries or group of countries to be considered. For the purposes of this paper, the chosen time horizon is 1890,[18] and the emissions are those considered under the Kyoto Protocol.

[18] Data before 1890 is less complete. Roughly 10% of the effect of total aggregated emissions is left out, when starting in 1890 instead of 1750, the start of industrialisation, see Höhne N, Blok K (2005) Calculating Historical Contributions To Climate Change - Discussing The 'Brazilian Proposal'. Climatic Change 71:141-173.

5.2.1. Reference Case (RC) Contributions

Historically, industrialised countries (as listed in Annex I) have contributed the majority of greenhouse gases, namely 54.5% – a figure which in the present simplified methodology represents their share in the causal contribution to the climate change problem. The causal contribution shares in detail, as represented in Figure 5, are (in descending order of magnitude) as follows: USA (19.7%), EU25 (17.8%), China (10.8%), AOSIS+LDC (5.7%) and India (3.9%).

These proportions can vary significantly depending on the sorts of gases and sources/sinks that are taken into consideration. For example, if emissions from land use, land use change and forestry (LULUCF), which are relatively uncertain, are excluded, Annex I contributions increase by almost a fifth (+10.2 percentage points), most of it absorbed by the US (+5.2%pts) and the EU (+4.3%pts), with chief beneficiaries Brazil (–2.3%pts, not shown here), Indonesia (-2.9%pts, not shown here) and AOSIS+LDC (–2.3%pts). The Chinese contribution does not change drastically (-0.4%pts), meaning that its share of emissions from LULUCF in total emissions is not very far from global average.

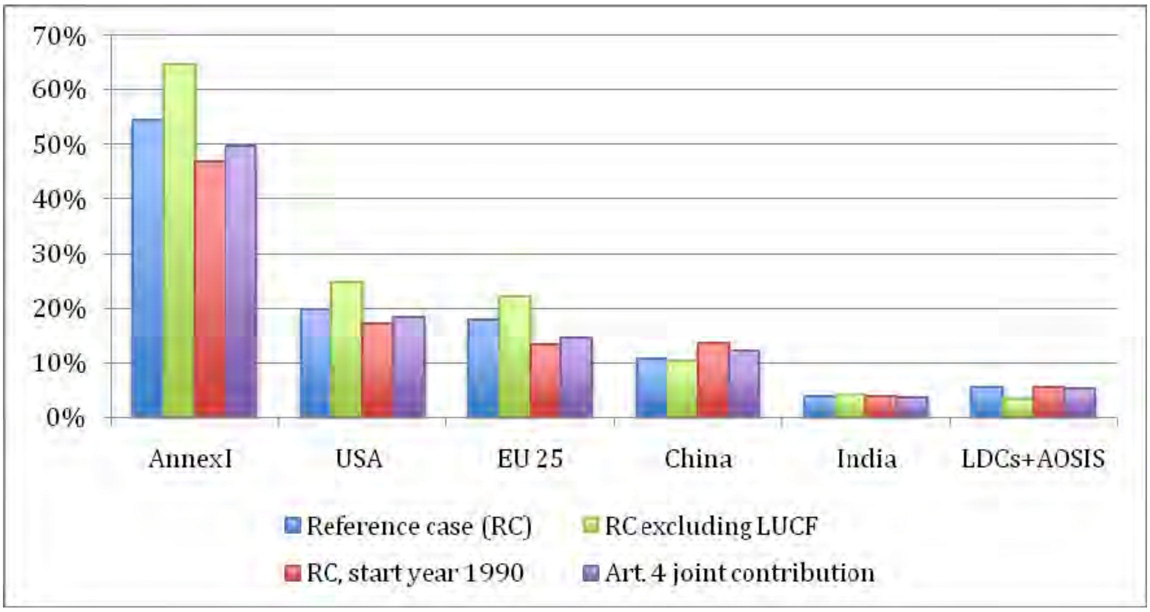

Figure 5. Causal contribution to climate change.

However, if one is talking of ‘causal contributions to climate change’ *tout court*, all (officially) recognised sources and sinks – including those from LULUCF – should be taken into account, which is why the Reference case is chosen for determining causal contribution shares.

5.2.2. Joint Contributions

As mentioned earlier, there are reasons to think that certain emissions, even though emitted over the sovereign territory of one country, should be given joint responsibility between different countries. The example put forward above was the case of emission increments in developing countries since 1992, when the world adopted the UNFCCC, and in particular its Article 4.

There may be other reasons as to why one might wish to introduce a joint responsibility for certain parts of ‘sovereign’ emissions, such as the ones embedded in exports, accounting for one third of total emissions in 2005 in China for example (Peters & Hertwich 2008, Weber et al. 2008). Indeed, a recent study contends that:

> "… the extent of 'exported carbon' from China should lead to some rethinking by government negotiators as they work towards a new climate change agreement. It suggests that a focus on emissions within national borders may miss the point. Whilst the nation state is at the heart of most international negotiations and treaties, global trade means that a country's carbon footprint is international. Should countries be concerned with emissions within their borders (as is currently the case), or should they also be responsible for emissions due to the production of goods and services they consume?" (Wang & Watson 2007a)

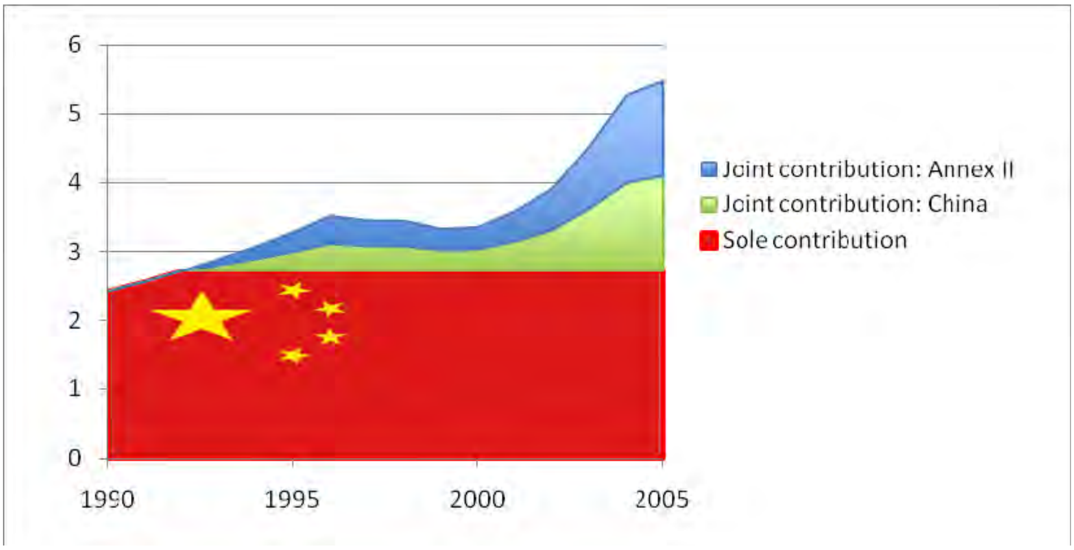

Figure 6. China's joint contribution.

The method of determining shared responsibilities used in this paper is able to accommodate this sort of joint responsibilities by introducing 'joint contributions.' And while the actual calculations of responsibility shares below will all be based on the more traditional sovereign-contributions-only approach embodied in the Reference Case (incl. LULUCF), it is useful to just give an illustration of how the inclusion of such joint contributions might change the picture. The exemplary implementation of joint-contributions (illustrated in Figure 6 for China) which is meant to reflect the duties under Article 4 simply assumes that the increment in emissions since and above the 1992 level are to be shared 50:50 by the countries in question and the rich industrialised (Annex II) countries[19] – divided among them in proportion to their GDP.

In order to have any significant variance from the sovereign country measures at all, the time horizon has also been limited to start in 1990. For the industrialised world, the switch to this sort of 50:50-joint contribution would mean in increase of 3 percentage points since 1990, most of it going in roughly equal to the US and the EU (+1%pt each), and benefiting mostly China (-1.3%pts). Given these differences would practically disappear if one were to use the Reference Case (beginning in 1890) it was decided not to proceed along these lines for the moment.

[19] As it happens, in 2004, the share of Chinese CO_2 (energy) emissions allocated to Annex II in this fashion is precisely the share of its embedded export emissions as calculate by Wang T, Watson J (2007b) Who owns China's carbon emissions. Report No. 23, Tyndall Centre for Climate Change Research, Norwich.

5.3. Differentiating Moral Responsibilities

5.3.1. Strict Responsibility

Strict responsibilities, according to the adopted allowance-based approach, are determined by the level of aggregate historic emissions – representing causal contributions – and a per capita allocation of the global total of harmless emissions. There has been some debate in the literature as to how much could be globally emitted without imposing harm, particularly in the context of defining what has become known as 'ecological space.' MacGregor (2006), for example, explains his choice of 4GtCeq (14.7GtCO$_2$eq) as follows:

> "The earth's natural ecosystems (both land and sea) currently absorb roughly half of the anthropogenic emissions of CO_2, thus buffering us from the full climate impacts of our emissions. However, this is a 'moving target' since future changes in climate will affect this rate of natural absorption. This in turn influences the future rate of change of atmospheric CO_2 since the warmer climate accelerates decay of carbon in soils and leads to large release of CO_2, which causes further warming. Moreover, the population is projected to increase. The current size of the global natural carbon sink is estimated to be 3-5 billion tonnes of carbon (GtCeq) – approximately 2 GtCeq by ocean and 1-3 GtCeq by land, depending on differing rates of deforestation. A global level of 4 GtCeq is often used (Monbiot 2007; Retallack 2005)." (MacGregor 2006)

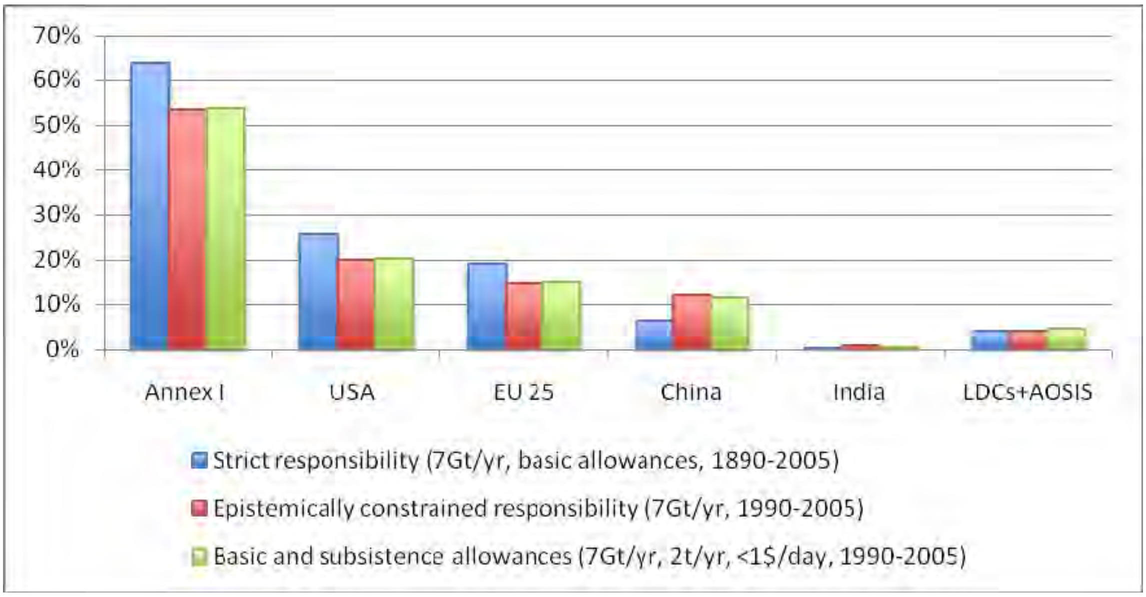

Figure 7. Moral responsibilities for climate change.

Agarwal, Narain and Sharma (1999) in turn contend that "terrestrial sinks are national property, but oceanic sinks, which absorb to the order of 2GtC [7.3GtCO$_2$] per year, belong to human kind and are common global property." (Agarwal et al. 1999) 7GtCO$_2$ as the global total of basic allowances has been adopted here, for the present purposes to be allocated – in accordance with their global commons status – on a per capita basis.[20]

As can be seen in Figure 7, numerically, this choice implies an overall industrialised country (historic) climate change responsibility of 64%. The largest single country share is that of the US with 25.6%, followed by the EU (19.1%), China (6.4%) and finally a number of countries with low if not negligible responsibility: AOSIS+LDC (4.1%) and India (0.3%).

[20] Strictly speaking, we should also have allocated basic allowances according to the sinks capacity of the respective sovereign territory, but given the uncertainties on how much these are, we decided to err on the side of caution and just consider oceanic sinks.

While it will not be surprising that individual SIDS and LDCs have really no historic responsibility for the climate change problem (on average 0.05%), what may be less expected is to find India at the very end of our responsibility spectrum. The reasons for the extremely low Indian responsibility share are its relatively modest causal contribution share of around 4%, and its rather large share in global population share (16.9%).[21]

5.3.2. Limited Responsibility I: Epistemic Constraints (EC)

There has been a robust difference of opinion – more often than not along the developed/developing country divide – whether it is fair to use this sort of strict historic responsibility, or whether countries should be granted mitigating circumstances, such as ignorance of the effect of one's actions. For the present purposes this sort of Aristotelian epistemic constraint of full responsibility has been implemented here by excluding emissions before 1990 from the calculations, on the grounds that after that year, which saw the beginning of the UNFCCC negotiations and the publication of the first IPCC reports, no government could reasonably plead ignorance of the problem.[22]

This plea for ignorance as mitigating circumstance does shift the burden of responsibility significantly from industrialised to developing countries, with Annex I as a whole losing 10 percentage points. The US (20.1%) and the EU (12.3%) both lose over a fifth of their responsibility relative to their historic strict responsibility shares, while China (12%) picks up about the same number of percentage points, but in this case this means almost a doubling of responsibility relative to the strict measure. In relative terms, by far the worst off is India (1%), which more than triples its responsibility under such a switch to ignoring most of the historic contributions. And yet it remains at the bottom of our responsibility scale, due to the extremely low base line. However, the developed/developing country picture is not quite as homogeneous as might be expected ("industrialised countries lose responsibility, developing countries gain"). Japan (3.7%, not shown here), for one, gains a third in responsibility, while Brazil (5%, not shown here), and AOSIS+LDC (4%) would actually be slightly better off. But, on the whole, the fact remains that in general a limitation of responsibility by considering only post-1990 contributions benefits industrialised countries.

5.3.3. Limited Responsibility II: EC With Subsistence Allowances

As mentioned earlier, Aristotle's conditions on limiting full responsibility lend themselves not only to justify these epistemic dispensations, but also a certain dispensation for subsistence emissions, or rather emissions needed to overcome (abject levels of) poverty. For the purposes of this paper, these needs based dispensations have been implemented as an additional constraint on the above-mentioned epistemic dispensation case. In other words, pre-1990 contributions continue to be disregarded in this context. This leaves two parameters to be determined: who should be eligible for the subsistence allowances, and how much should they be. The most readily available data are listed in the World Bank Development Indicators, which contains figures for people living on less than $1 and 2$ per day. As to the question of how much should poor people be allowed to emit without incurring responsibilities, per capita subsistence allocations of less than the relevant global per capita

[21]The position of Japan in this strict responsibility scale (2.8%) also suggests that burden sharing according to responsibility alone may not really be tenable, and that it would have to be complemented with some 'respective capacity' component, as referred to in Article 3.1 on the UNFCCC.

[22] This is, of course, not quite the same as saying that they could not have reasonably been expected to know even before this – as referred to above – but for the sake of argument, we shall use 1990 in accordance with the principle of the presumption of innocence ("Giving the defendant the benefit of the doubt").

basic allowance will not register.[23] Given that the per capita emissions of the developing world are currently estimated to be 3.7 and 2 tCO_2eq with and without LULUCF, respectively our decision was to allocate $2tCO_2$ per poor inhabitant per annum, to be subtracted from the aggregate historic emissions (instead of the basic allowance)

In this case of 1$/day as 'poverty threshold' – referred to simply as 'Limited Responsibility' – the annual subsistence allowance of $2tCO_2eq$. (which is larger than basic allowance per capita level) is used instead of the basic one for each inhabitant with an income of less than 1$ per day. The results benefit developing countries more than developed ones, and yet the shift of half a percentage point in responsibility towards Annex I (53.8%) is clearly not compensating for the shift in the other direction due to the introduction of the epistemic constraint. The US gains 0.2 percentage points relative to the epistemologically constrained case, while India and China jointly loose nearly one. And the situation does not differ significantly if one moves the poverty threshold to 2$/day: The US gains another 0.6 percentage points, while China and India jointly loose 1.2 percentage points. In other words, the choice of poverty threshold – at the assumed level of $2tCO_2eq$. for the subsistence allowance – is not a particularly sensitive one, certainly not in comparison to the effects of the chosen epistemic constraint, or the overall level of basic allowances.[24]

5.4. Mitigation Through Population Control?

Since the end of the 1970s, China has taken extraordinary measures to curb the growth of its population. Based on the undoubted achievements of the policies that were implemented, Chinese politicians have repeatedly argued that population control is one of the most successful strategies to curb emissions and coin it as one of the key mitigation efforts of China. The underlying assumption is that the increase in emissions would have been faster with higher population growth.[25]

Estimates vary on the size of the current population in absence of the policies that were implemented, and there is not any single number that is more correct than any other when looking at this hypothetical case. To simplify, we extrapolate 1978 population figures to 2005 at the growth rate of the population from the founding of the People's Republic in 1949 to 1978, leading to a hypothetical population of 1.62 billion instead of 1.3 billion in 2005. We then calculate the hypothetical emissions for the years 1978 to 2005 by multiplying actual emission with the factor of actual to hypothetical population of each year, which results in hypothetical Chinese emissions of $8.7GtCO_2eq$. instead of $7GtCO_2eq$. in 2005.

[23] 16 (1990-2005) times the annual basic allowance budget of $7GtCO_2eq$, divided by the sum of global annual population figures over the period = $1.2tCO_2eq$.

[24] See Müller et al. (2009) for a full sensitivity analysis for varying choices of Basic and Subsistence allowances.

[25] It can be questioned if the difference in hypothetical to actual emissions growth would have been the same as the difference in hypothetical to actual population growth. Economic growth, industrialisation and modernisation since the end of the 1970s may have rather been hampered by overpopulation, leading to an elasticity lower than 1.

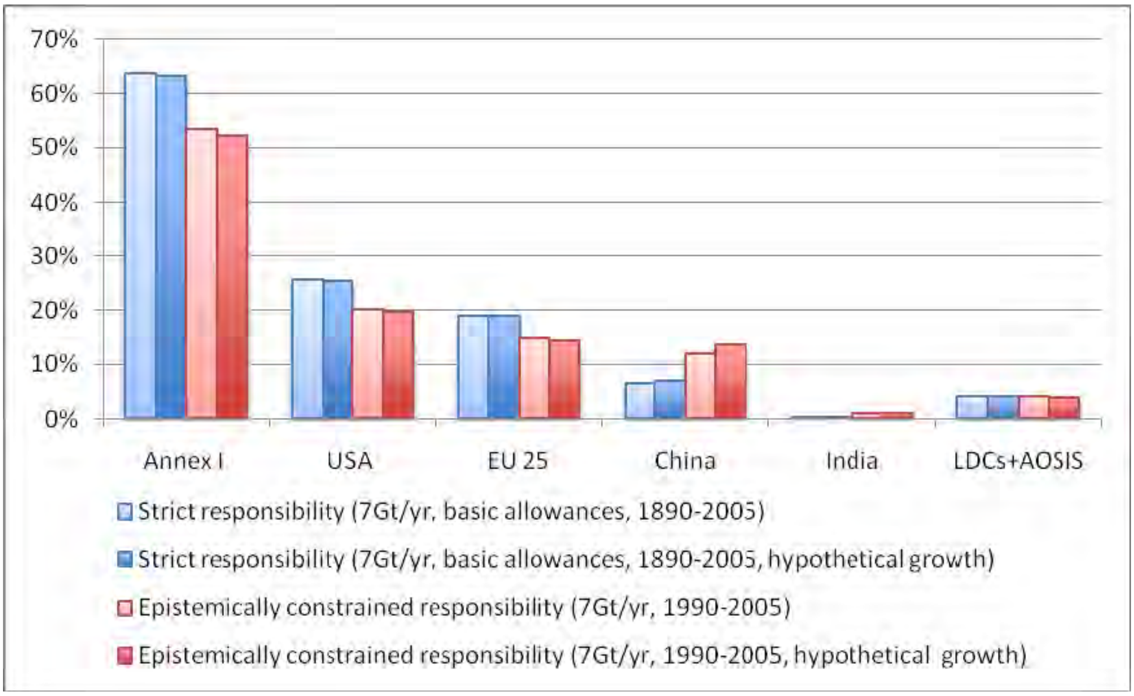

Figure 8. Hypothetical responsibility with faster Chinese population growth.

Figure 8 shows the new responsibility shares for a higher Chinese population and emissions growth. Note that the increase in the allocated share of basic allowances for its hypothetical population offsets part of the increase in responsibility for China.

Shares in strict responsibility and epistemically constrained responsibility for Annex I countries (-0.5/-1.1%pts.), USA (-0.2/-0.4%pts.) and EU25 (-0.2/-0.3%pts.) are lower in this hypothetical case and the shares of LDCs and AOSIS remain virtually unchanged. Interestingly the responsibility shares of India increase by 10%/8% (but still less than 0.1%pt.) because in relation to its low emissions the country profits most from the allocation of basic allowances, part of which are diverted to China due to a higher share in world population. The share of China's strict responsibility increases to 7.1% from 6.4% and for epistemically constrained responsibility to 13.6% from 12%. With all the caveats noted regarding the assumptions underlying this hypothetical calculation, China has reduced its responsibility for climate change by 10% and 13.5%[26] respectively by means of population control.

5.5. What is The Future of Historical Responsibility?

China has undoubtedly started to implement numerous policies that have a climate change mitigating effect (Ellermann et al. 2009 forthcoming). In the deliberations of the coming 12th Five-Year-Plan for China's development strategy, a general consensus exists for a more sustainable development path. However, proponents of a low-carbon future for China face opposition by others who suggest that China should focus on unrestrained business-as-usual development until 2030 before worrying about (unilateral domestic) climate change mitigation.

The 12th Five-Year-Plan plan covers the years 2011 to 2015 and will among other things provide guidance for economic restructuring and major investments in infrastructure and capital with long turnover rates like energy generation and heavy industry facilities. Decisions made this year therefore predetermine to a large degree China's general emissions trajectory over half a century or so to come. A careful look into the future (up to the often-

[26] Note: percent, not percentage points.

cited year 2030) and its potential responsibilities including historical (pre-2005) and new emissions therefore seems to be warranted. Figure 9 and Figure 10 corroborate this point, as emissions between 2006 and 2030 make up the largest part of total emissions since 1890, with an average annual contribution of over 1.6% after 2005.

We are mindful of the difficulty of predicting future emissions and rely directly on the MATCH calculations. The MATCH group used latest available emissions data (2005) and extrapolated country emissions using an average of the six basic IPCC SRES scenarios for 17 world regions, avoiding a judgement on the probability of any single scenario to be more "correct" than others. The point of this paper here is ***not*** to come up with a reliable number of future emissions, but to illustrate the potential future direction of historical responsibility. In contrast to the previous sections, this paper cannot provide a clear ethical argument for the metric used (and as a consequence the use of the results), as it builds the sum of *actual* historic emissions and *potential* future emissions, complicating the interpretation of the results. The numbers provided are therefore simple results of a calculation based on the scientific consensus of the IPCC over future emissions, but lack the power of an ethical analysis of future historical responsibility. [27]

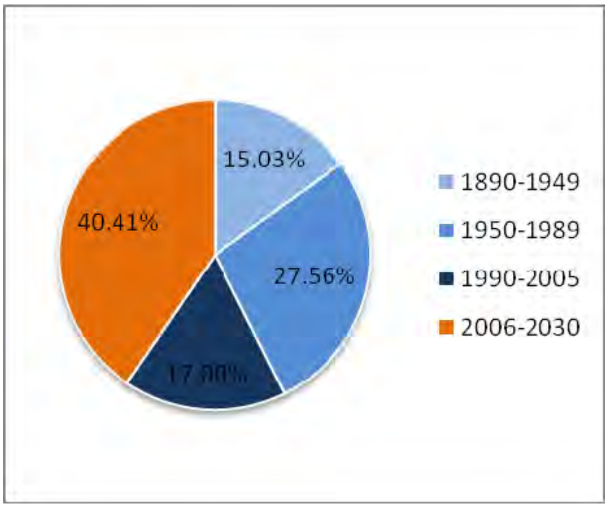

Figure 9. Total contribution during different time periods.

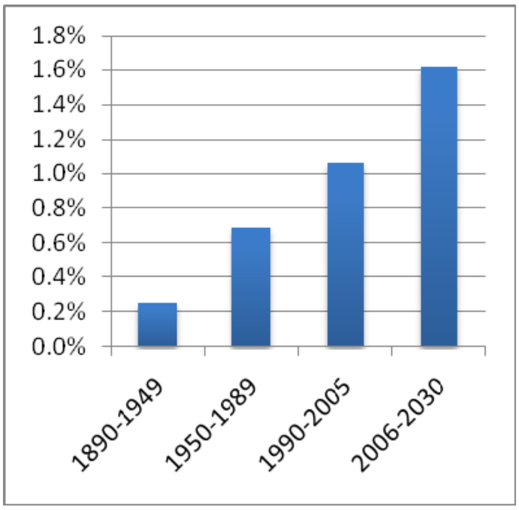

Figure 10. Annual contribution during different time periods.

The look into the future reveals potentially significant shifts in the shares of responsibilities of countries and regions (Figure 11, lighter colour shows actual historical responsibility, darker colour shows "potential future historical responsibility"). Strict responsibility of Annex I countries would be 53.8% (-10.1%pts), epistemically constrained responsibility would be 45.2% (-8.1%pts.). The shares of the USA would decline by 5%pts. to 20.6% and 3.9%pts. to 16.2%, and EU25 to 15.8% and 12.6% respectively (-3.3/-2.1%pts.). China's share of strict responsibility would rise sharply to 12.1% (plus 5.7%pts. or 88.3%) and epistemically constrained responsibility would increase by 4.8%pts. (or 40.4%) to 16.8%, overtaking the potential shares of the USA and the EU25 and potentially amounting to more than a third of Annex I total by 2030. India's potential responsibility shares rise to 2.6% and 4% respectively (2.3%pts./3%pts. and a drastic relative increase), while LDC/AOSIS potential shares drop slightly. The Rest of World responsibility shares

[27] The question of the use of future emissions – modelled in emission scenarios – to calculate the historic responsibility at an end year that lies in the future should be an interesting research topic in this field. An argumentation could perhaps start in this direction: In the case one considered pre-2030 emissions completely predetermined by today's decisions on energy strategy, etc. and considered the modelled emission scenario an accurate description of future development, these future emissions could already be assumed to be historic today. Then they could be summed up with actual historic emissions.

change moderately from 25.3% to potentially 27.8% and 29.7% to 30.5%, meaning that its emissions would grow around world average, especially after 1990.

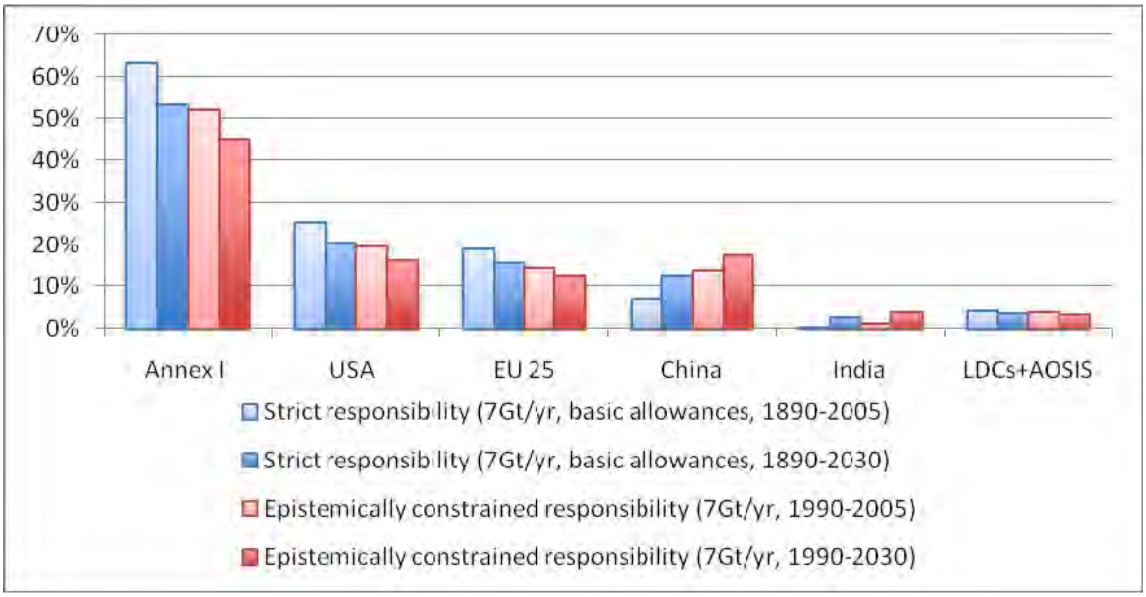

Figure 11. A scenario for future (historical) responsibility for climate change.

The direction of these numbers – which as noted before should not be interpreted as an ethical analysis of future historic responsibility but merely as a calculation based on commonly agreed emission scenarios – could potentially have great implications for the ethical debate surrounding climate change and point to the use of future emissions scenarios as an important research topic when looking at historical responsibility.[28] So far there is no ethical concept for combining actual historic responsibilities and potential future responsibilities, and the calculations here cannot be used for their absolute numerical results. Their direction however suggests that by 2030 historical responsibility shares could be distributed quite differently from today, changing the force of the principle of "common but differentiated responsibility" for some major players. China could potentially become similarly responsible for climate change as the USA or the EU25, and India's responsibility could surpass that of Germany or Japan. Undoubtedly – and this is important – this still leaves intact low per capita emissions as the other major argument for "common but differentiated responsibility", and it does not affect the argument of limiting capabilities of now developing countries to combat climate change.

6. Concluding Remarks

The aim of this paper was to put forward and discuss a methodology for the numerical differentiations of responsibilities for climate change as opposed to calculating causal contributions to climate change. For expository purposes, this was done on the basis of aggregate GWP-weighted historic emissions as a proxy. Moving to fully fledged climate modelling techniques as used in MATCH could be done in the future, but would change the relative contributions and resulting responsibilities by at most 10%[29] for most countries.

This paper is not aimed to engage in a debate which of the two conceptions of responsibility ('strict' or 'limited') with the chosen parameter values is more appropriate, or whether the causality of developing country emissions should be partially attributed to Annex

[28] Chen et al. (1999) early on pointed out the changing trend of contribution shares, comparing pre-1990 historical contribution with estimated contribution over the period of 1990-2010.
[29] Percent, *not* percentage points.

II countries, not least because the answer may well depend on what one wishes to do with the results. However, the order of magnitude difference in the responsibility of the two extremes of the scale under both conceptions does give pause for thought as to what sorts of burdens can justly be imposed, particularly given the discrepancy between the affluence and wealth of the exponents at either end of the spectrum of responsibilities we considered in this paper.[30]

While the ethical argumentation for these two conceptions of responsibility are pretty developed and less contentious, it is still not very clear how future potential emissions can be incorporated into a (historic) responsibility concept to include the most likely emission scenarios for the coming one to two decades. We can predict with some certainty that the historic responsibility of countries in 2030 will look quite different from today. Our ability to see this today points to the need for increased research on this matter – on the future of historic responsibility.

It stands to reason that burden sharing on the basis of historic responsibility alone – as proposed in the original Brazilian proposal – without taking into account the second and lesser quoted element mentioned in Article 3.1 of the UNFCCC, namely 'respective capabilities', would not be appropriate. In other words, fair burden sharing would have to be based on a mixture between the responsibility shares discussed here and some differentiated index of capability.

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[30] Affluence (GDP per capita, PPP): US = $41,890, India = $3,452. Wealth (GDP, PPP): India = $3.8tr, US = $12.4tr. (both in 2005). Source: World Bank (2006) World Development Indicators 2006, Vol. World Bank, Washington D.C..

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