FOUR

Differentiating historical responsibilities for climate change

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Climate change has strong ethical dimensions, and global solutions to this problem are unlikely to be crafted, or to be stable, without some broad conception of what is fair (see IPCC, 1996; Stern, 2006). There is a burgeoning literature on these dimensions (Müller, 2001; Gardiner, 2004; Brown et al, 2006; Klinsky and Dowlatabadi, 2009; Harris, 2010; see also Chapter Six), with part of this work focusing on historical responsibility for climate change (Botzen et al, 2008; Friman and Linnér, 2008; Klinsky and Dowlatabadi, 2009). The notion of historical responsibility for climate change of 'Annex I' (that is, developed country) parties to the United Nations Framework Convention on Climate Change (UNFCCC) has been regularly invoked by developing-country governments. Historical responsibility is also one of the main lines of argument underlying the principle of common but differentiated responsibility for climate change, and the polluter pays principle more generally. Discussion on equity – 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's official position (Ellermann and Mayer, 2010), framing understanding of the country's ethical position vis-à-vis developed countries and the rest of the world.

In this chapter, we examine the Chinese position on responsibility for climate change by drawing on the results of the Ad-hoc Group for the Modelling and Assessment of Contributions of Climate Change (MATCH), a group that was created in 1997 following a proposal from Brazil (UNFCCC, 1997). The MATCH group has concentrated on the causal attribution of historical greenhouse gas (GHG) emissions to countries (see Ito et al, 2008; Prather et al, 2009; Höhne et al, submitted).[1]

Contributions versus responsibility

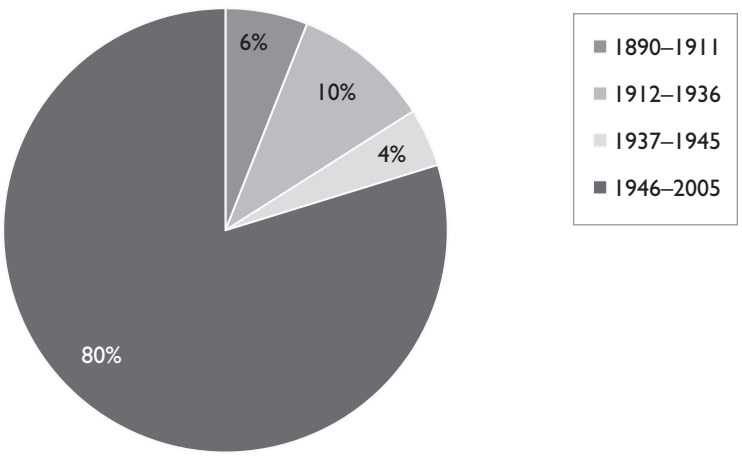
Climate impacts, whether anthropogenic or due to natural variability, will inevitably have a multitude of causes. The moral responsibility for climate impacts will typically be shared by a number of actors. There is a link between a moral agent causally contributing to an impact and being (partly) morally responsible for it, but that does not mean that the two are the same. The MATCH project modelling focused on determining the *causal contribution* of GHGs covered under the UNFCCC to certain climatic impacts, in particular to changes in mean global temperature. The message from the project is that we cannot accurately discuss causal contributions to climate change per se, at least not if one is intent only on specifying numerical shares thereof, because such calculations require making normative decisions. One of the key normative decisions is the way in which emissions are associated with particular countries. It is one thing to say that a series of emissions has contributed a certain percentage to the increase in global mean temperature over the 20th century, for example, and quite another to say that China has done so. The former is purely scientific, whereas the latter involves a normative decision of how to identify 'the emissions of China' at a given time.

The implicit assumption of the MATCH team was that anthropogenic emissions associated with a particular country for a given period of time are those emitted from within its sovereign territory, and that 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 for the increments in emissions in developing countries since the convention was signed in 1992.[2]

The normative issue of identifying the sovereign emissions of China is not completely straightforward because the sovereign territory of the People's Republic of China has changed through history. In this chapter, we rely on the decisions regarding the attribution of the emissions made by the MATCH team. The data recorded for China are largely dominated by emissions from fossil-fuel combustion, as recorded in Marland et al (2005), for 'mainland China' (that is, excluding Hong

Kong, Macau and Taiwan). Figure 4.1 displays emissions during different historical periods. Until 1911, China was under the rule of the Qing Dynasty, but during some of this period, parts of the country were occupied by foreign powers. However, there was no major colonial rule over China that would warrant a deep discussion of the attribution of emissions during that time, which amounted to 6% of total emissions between 1890 and 2005. The period from 1912 to 1937 saw major domestic conflict, with warlords fighting over regional rule in the Republic of China. There should be little question over the attribution of emissions during this time, which amounted to 10% of China's emissions from 1890 to 2005. In contrast, major parts of China were occupied by Japan from 1937 to 1945. Marland attributes all emissions during this period to China (mirroring similar decisions about other countries, such as the attribution of pre-independence emissions throughout current Indian territory to India, rather than to the colonial power, the United Kingdom). In spite of the rapid industrialisation and deforestation during this time, the share of these nine years amounted to only 4% of total Chinese emissions.

Figure 4.1: China's emissions of GHGs during different historical periods



Source: Authors calculation based on MATCH dataset

From 1946 on, sovereign rule over all of mainland China again became clearly Chinese. This historical period contributed 80% of the emissions from 1890 to 2005. While the question of Chinese sovereign emissions is not absolutely straightforward, the contribution during historical

periods that could be contentious (1890-1911 and 1937-1945) make up only 10% of total Chinese emissions. In practice, therefore, the relevance of the normative debate surrounding this issue is limited. It may be safe to assume that this applies to most countries that have not seen major changes in territory since 1945.

Types of responsibility

To be responsible for something harmful is to be worthy of blame for it.[3] Aristotle (1908: III.1-5, 1110a-1111b4) contended 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:

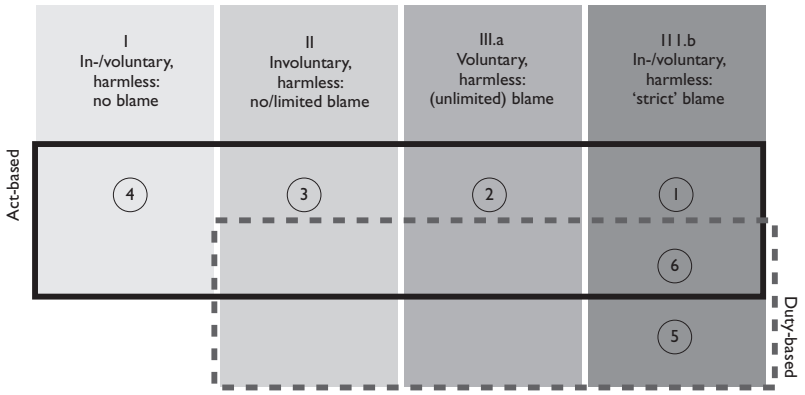
> First, there is a control condition: the action or trait must have its origin in the agent. That is, it must be up to the agent whether to perform that action or possess the trait — it cannot be compelled externally.
>
> Second, Aristotle proposes an epistemic condition: the agent must be aware of what it is she is doing or bringing about. (Eshleman, 2004)

However, ignorance per se seems to be slightly too easy for pardoning, which is why the condition is usually strengthened in so far 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 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 4.2 is an attempt at representing the interplay between the distinctions of voluntary/involuntary, harmful/harmless, agency/duty based and type/level of blameworthiness (responsibility). Aristotle's conditions on assigning blame to actions (and to agents) are about whether they are carried out voluntarily or involuntarily. However, as illustrated in Figure 4.2, 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's conditions, 'strict' blame (responsibility) is handed out simply because the effects are harmful,

regardless of whether the harm was done voluntarily or involuntarily (category III.b).

Figure 4.2: Categories of blame/responsibility



In the context of climate change, blame/responsibility is usually seen as applying to certain acts, namely the emissions of GHGs; thus, blame 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 Figure 4.2), or because they drove voluntarily, in the full knowledge of the harmfulness of the emissions 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).

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

have to take responsibility for the whole of the emissions increment she failed to reduce because there was a joint dereliction of duty (⑥).

Differentiating contributions and responsibilities

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, and they depend on the sequential order of the emissions series in question. However, to simplify calculations for this chapter, it is possible to use the sum of historical emissions (or their relative size) as a reasonable approximation for relative causal contributions (den Elzen et al, 2005; Hope, 2008). Here we use aggregate historical country emissions emitted between 1890 and the present (2005) – using 1995 Global Warming Potentials (GWPs) for different gases consistent with the Kyoto Protocol – as determinants of responsibility.[4] Using GWP factors can only be considered an approximation; they ignore the feedbacks and long-term changes in global warming potentials. Marginal damage from a unit of emissions is smaller today than it was at the beginning of industrialisation. For simplicity, we assume that emissions at all times are weighted equally by using constant GWPs (see Höhne and Blok, 2005).

The problem with either aggregate (that is, 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 other facets. 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 emissions figures, on the other hand, do reflect population size, but they are unable to reflect causal contributions. For example, they would assign the same responsibility to both China and Latvia, with 0.8tC/cap in each country, despite there being 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 emissions-based responsibilities, which should be quantified in absolute terms (that is, 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 and economic production. Traditionally, these relativisations have been operationalised by simple parameter divisions, such as per-capita and per-unit-of-economic-output (Gross Domestic Product; GDP) measures. For example, Baer et al (2008) name 'cumulative per-capita CO_2 [carbon dioxide] emissions from fossil fuel consumption since 1990' as a 'reasonable' definition of responsibility. Research institutes close to the Chinese government have in recent years undertaken significant work in a similar direction; they promote 'cumulative per capita emissions … as an indicator for equity' (Pan et al, 2009).[5]

Aggregate country or regional responsibility for climate change (impacts) should be relativised in the sense that it has to be measured in multi-parameter terms, including – apart from emissions – the size of (certain) populations. The traditional operationalisation in per-capita terms oversimplifies the situation. Instead, in this chapter, we use a bottom-up, allowance-based methodology. This 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 tax burdens. There can be different kinds of 'climate change responsibility allowances' depending on the (moral) justification for why they should be allocated. For example, if a certain level of GHG emissions is deemed to be harmless, then one would have to allocate what we call 'basic allowances' to cover these harmless emissions, on the grounds that no person 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 one's control. This kind of allowance has been implemented by looking at 'subsistence allowances', based on the assumption that poverty eradication is an overriding moral aim, and that in present circumstances it can only be achieved through activities that generate GHG emissions. There may be other basic needs-based allowances that might have to be considered, such as the need to keep temperatures within certain boundaries in order to ensure people's survival. The Aristotelian epistemic condition that one should not be held responsible for actions that one could not have reasonably been expected to 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 that 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. The latter ought to be used only as a 'back-up' to the former, should both be issued, and not as a complement.

Apart from the question of what sort of allowances should be counted against one's responsibility for climate change, a key issue with this sort of methodology is how to allocate them. In the case of basic and subsistence allowances, we believe that a 'bottom-up' approach to country allocations – a definition of country allocations in terms of personal ones – is most appropriate. In the case of epistemic allowances for operationalising 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 emissions occurring in justifiable ignorance of their harmfulness be covered by allowances. Personal basic allocations should be allocated on an egalitarian principle for the same reasons that support the per-capita allocation of global emission permits.[6] The bottom-up methodology, then, implies that countries can disregard some of their emissions in responsibility calculations, using the following formula:

$b \times p_i$ (where b is the global per-capita figure of harmless emissions, and p is the population of country/region i)

Population figures enter allocation-based country responsibility measures, which is quite different from traditional per-capita measures.[7]

The difference becomes even more marked if other population-related allowances are considered. While there are arguments for a differentiated allocation (according to particular needs) in the case of subsistence allowances, it is clear that if emissions are equally allocated they would normally not be allocated to the whole population of a country, but rather to those who are living below a set 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. However, unlike in the traditional per-capita methodology, the populations in question are not *all* inhabitants but rather only special-needs groups, for example 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' people hide behind their carbon-poor compatriots – as can happen in the case of the traditional per-capita methodology.[8]

The Chinese discourse on historical responsibility

Historical responsibility for climate change has been discussed in Chinese publications, with authors concentrating mainly on direct historical contribution of countries' CO_2 emissions from energy use (He et al, 2000; Zhao, 2007; Xu and Yu, 2008). According to a number of Chinese authors, developed countries bear responsibility for climate change because they have emitted 77% of CO_2 emissions from fossil-fuel use from 1950 to 2000.[9] He et al (2000, p 2) argue for actively using 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 surpass Annex I emissions only in 2037, and cumulative emissions only in 2147.[10] An analysis that goes beyond directly equating contribution shares to historical responsibility is lacking from these analyses, and it is usually restricted to the developed–developing country divide. However, Chen et al (1999) analyse the topic starting with the Brazilian Proposal of 1997 (UNFCCC, 1997), using that proposal's underlying concepts and calculations of national contributions to climate change. Comparing current (1990-2010) with historical contribution shares, Chen et al (1999) conclude that China's interests would not be served if it was singled out from the group of developing countries in analysing historical responsibility.

What is China's official view on responsibility for GHG emissions? The Chinese government first put forward a coherent climate policy in 2007. Its views on the application of historical responsibility for climate change have become manifest in various official documents. For example, government ministries have declared that:

> 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. (NDRC, 2008)

> According to the principle of 'common but differentiated responsibilities' of the UNFCCC, the Parties included in Annex I to the Convention [developed countries] should take the lead in reducing greenhouse gas emissions. For developing countries with less historical emissions and current low per capita emissions, 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 [the] global climate system. (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 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. (NDRC, 2009)

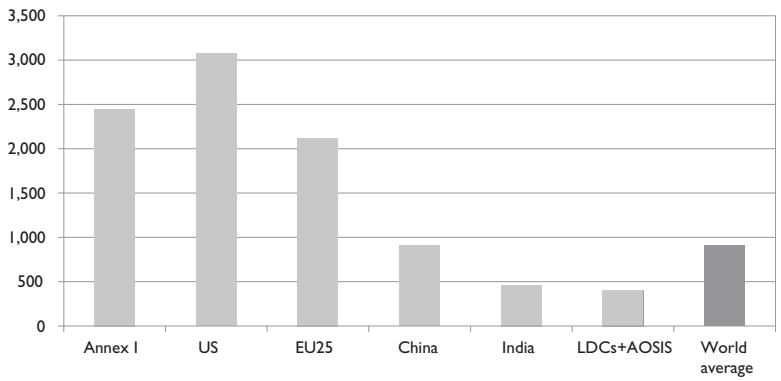
> Climate change is primarily caused by developed countries' historical emissions over many years. (MOFA, 2008)

Similar to the Chinese academic views, the official line is that, first, China is a developing country, and second, 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 historical responsibility, China is not mentioned individually but generally as a member of the group of developing countries with little responsibility overall.

The Chinese position on historical responsibility has become more clearly defined over time. A main purpose now seems to be to develop an effort-sharing scheme based on ideas of historical contributions to climate change. For some time, China subscribed to a position, shared by some other developing countries, that does not allow for global reduction commitments, but instead differentiates reduction targets for

Annex I countries by historical responsibility. More recently, however, China has started to formulate its own position, a 'cumulative per-capita emissions convergence' approach. It does not focus on historical responsibility shares as we do here, but instead bases responsibility on egalitarian grounds that require equality of cumulative historical and future country emissions divided by the population at the time of the target year (2100 in a Chinese proposal).[11] Figure 4.3 shows this calculation based on MATCH data. A more recent refined version of this approach works with 'per-capita emissions entitlements' (which only at first sight appears to be similar to our allocations) that would lead the world towards a global atmospheric concentration of 470ppmv CO_2 in 2050. Emissions budgets are then used that run either a surplus or a deficit in 2005, depending on the sum of a country's emissions above or below its population's 'entitlement' each year; equal cumulative per-capita emissions over time (operationalised as a budget of zero) are required in 2050.[12]

Figure 4.3: Cumulative emissions per capita in 2100 using MATCH data



Note: LDCs = Group of Least Developed Countries; AOSIS = Alliance of Small Island States.

Source: Authors' calculations based on MATCH dataset.

Context

For this chapter, causal contributions to climate change were calculated for all countries, but in the remainder of the chapter we will focus on three individual countries – the United States (US), India and of course China – and three groups of countries – the group of industrialised countries listed in Annex I of the UNFCCC, the European Union

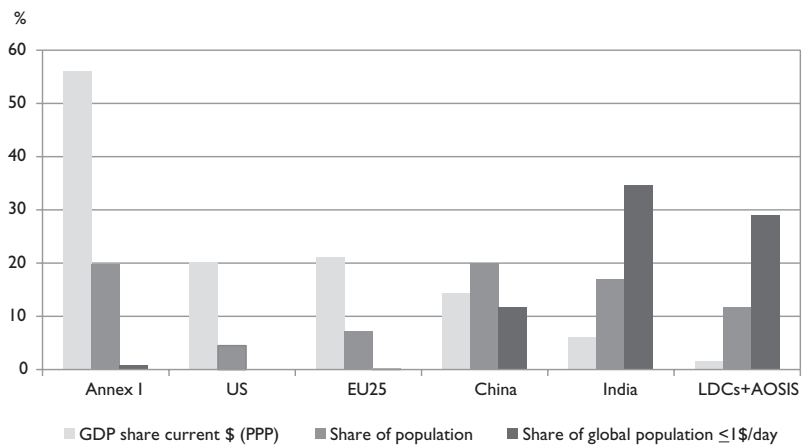
(EU) after the 2004 enlargement (the so-called 'EU25' countries), and the Group of Least Developed Countries combined with the Alliance of Small Island States (LDCs+AOSIS, totalling 76 countries).

Figure 4.4 depicts three non-emission parameters for the year 2005 (the last year of observed emissions in the MATCH dataset) that are of interest in discussing of the contribution to, and responsibility for, climate change by these countries and country groupings, in particular their share of:

- global wealth (defined in terms of current GDP purchasing power parity [PPP]);
- global population; and
- global poverty (measured in terms of the number of people living on US$1 or less per day).

Not surprisingly, the developed and developing worlds (Annex I/non-Annex I; North/South) are not the same with respect to these three dimensions: While the 20% of the world population who live in Annex I countries produce 56% of global wealth, the non-Annex I countries are home to 99.2% of the world's very poor people. These proportions have some impact in our responsibility calculations. For example, consider the fact that in 2005 China's global share in abject poverty of 12% translated into 129 million people, and India's 35% into 377 million, while the population of those living below US$2 (PPP)/day was 454 million in China, and a staggering 881 million in India.

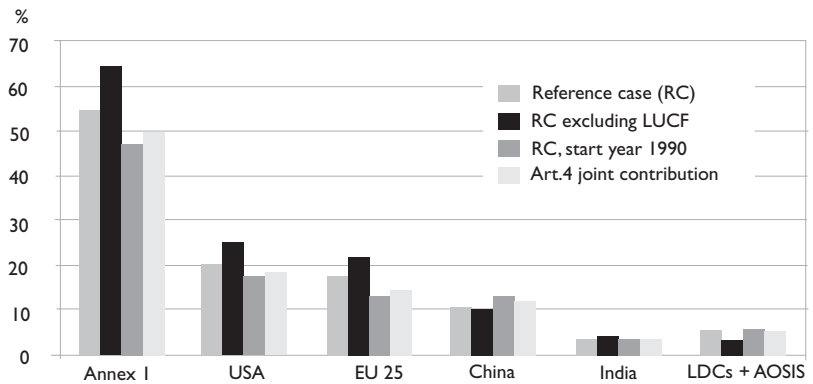
Figure 4.4: Economic and demographic context (2005) (%)



Source: Authors' calculations based on MATCH dataset.

According to our simplified methodology, the share of a country's (or a group of countries') contribution to climate change is determined by their share in the global warming potential of their historical GHG emissions. However, to be able to calculate these shares, some further parameters need to be specified, such as the timeframe, the types of emissions and the countries or groups of countries to be considered. For the purposes of this chapter, the chosen time horizon begins in 1890 and the emissions are those considered under the Kyoto Protocol.[13] Historically, industrialised countries (as listed in Annex I of the UNFCCC) have contributed the majority of GHGs to the atmosphere, namely 54.5%, a figure that 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 4.5, are (in descending order of magnitude) the US (19.7%), EU25 (17.8%), China (10.8%), LDCs+AOSIS (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 percentage points) and the EU (+4.3 percentage points), with chief beneficiaries Brazil (–2.3 percentage points, not shown here), Indonesia (–2.9 percentage points, not shown here) and LDCs+AOSIS (–2.3 percentage points). The Chinese contribution does not change drastically (–0.4 percentage points), meaning that China's

Figure 4.5: Causal contribution to climate change



Note: LUCF = land-use change and forestry
Source: Authors' calculations based on MATCH dataset.

share of emissions from LULUCF in total emissions is not very far from the global average.

Differentiating causal contributions

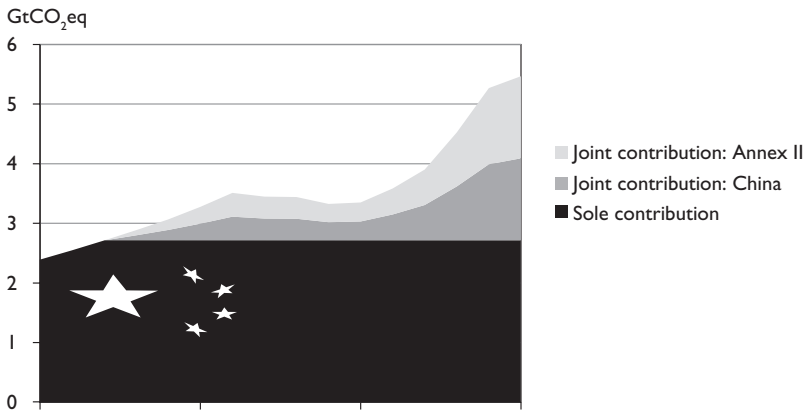
Certain emissions, even when emitted over the sovereign territory of one country, should result in joint responsibility among more than one country. An example can be found in impact of China's exports:

> [T]he 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 and Watson, 2007)

In this chapter we accommodate this shared responsibility by introducing 'joint contributions'. Figure 4.6 depicts the joint contributions of China and other developing countries.

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

Figure 4.6: China's joint contribution with Annex II countries



Source: Authors' calculations based on MATCH dataset.

contribution would mean an increase of 3 percentage points since 1990, most of it going in roughly equal measure to the US and the EU (+1 percentage point each), and benefiting mostly China (–1.3 percentage points). 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.

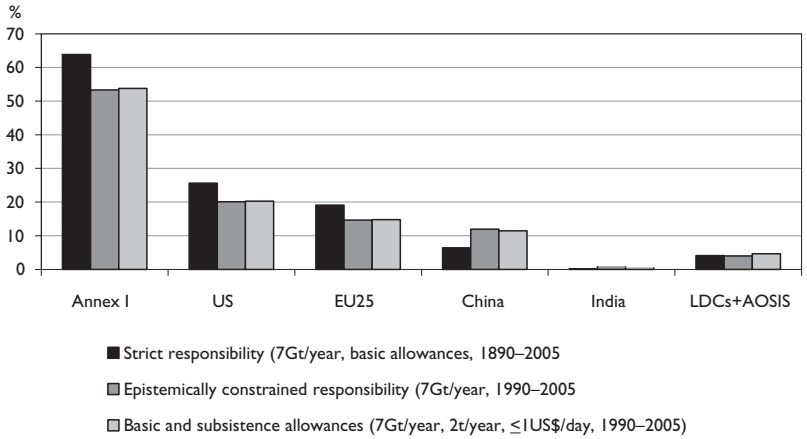
Differentiating moral responsibilities

Strict responsibility

Strict responsibilities are determined by the level of aggregate historical emissions – representing causal contributions – and a per-capita allocation of the global total of harmless emissions according to the allowance-based approach outlined above. 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'. Commonly used values range between 2 GtC (gigatons of carbon) (7.3 $GtCO_2$) per year for oceanic sinks alone (Agarwal et al, 1999) and 4 GtCeq (gigatonnes of carbon equivalent) (14.7 $GtCO_2eq$) that also include terrestrial sinks (Retallack, 2005; MacGregor, 2006; Monbiot, 2007). Seven $GtCO_2$ as the global total of basic allowances has been adopted here, for the present purposes to be allocated on a per-capita basis.[14]

As can be seen in Figure 4.7, numerically, this choice implies an overall industrialised country (historical) 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: LDCs+AOSIS (4.1%) and India (0.3%). While it will not be surprising that individual AOSIS (Alliance of Small Island States) and LDCs have really no historical 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 global population share (16.9%), which determines the allocation of allowances.[15]

Figure 4.7: Moral responsibilities for climate change (%)



Source: Authors' calculations based on MATCH dataset.

Limited responsibility I: epistemic constraints

There has been a robust difference of opinion – mostly along the developed–developing country divide – as to whether it is fair to use strict historical responsibility, or whether countries should be granted mitigating circumstances, such as ignorance of the effect of one's actions. This 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 reports by the Intergovernmental Panel on Climate Change (IPCC), no government could reasonably plead ignorance of the problem.

This implementation of ignorance as a 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 historical strict responsibility shares, while China (12%) picks up about the same number of percentage points. For China this means almost a doubling of responsibility relative to the strict measure. This is certainly due to the much later onset of large GHG emission quantities, following the rapid economic development in the past two to three decades. On the whole, a limitation of responsibility by considering only post-1990 contributions benefits industrialised countries.

Limited responsibility II: epistemic constraints with subsistence allowances

One may argue for a certain dispensation of allowances for subsistence emissions, or rather emissions needed to overcome (abject levels of) poverty. For the purposes of this chapter, 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 contain figures for people living on less than US$1 and US$2 per day. Our decision was to allocate 2 tCO_2 (total CO_2) per poor inhabitant per annum – equivalent to current non-forestry per-capita emissions of the developing world – to be subtracted from the aggregate historical emissions (instead of the basic allowance). In this case of US$1/day as the 'poverty threshold', the annual subsistence allowance of 2 tCO_2eq (which is larger than basic allowance per-capita level) is therefore used instead of the basic one for each inhabitant with an income of less than US$1 per day, for example 129 million people in China in 2005.

The results benefit developing countries more than developed ones. The shift of half a percentage point in responsibility towards Annex I (53.8%) does not, however, make up for the shift in the other direction due to ignoring pre-1990 emissions. The US gains 0.2 percentage points relative to the epistemologically constrained case, while India and China jointly loose nearly 1. And the situation does not differ significantly if one moves the poverty threshold to US$2/day. In other words, the choice of poverty threshold is not a particularly sensitive one, especially not in comparison to the effects of the chosen epistemic constraint, or the overall level of basic allowances.[16]

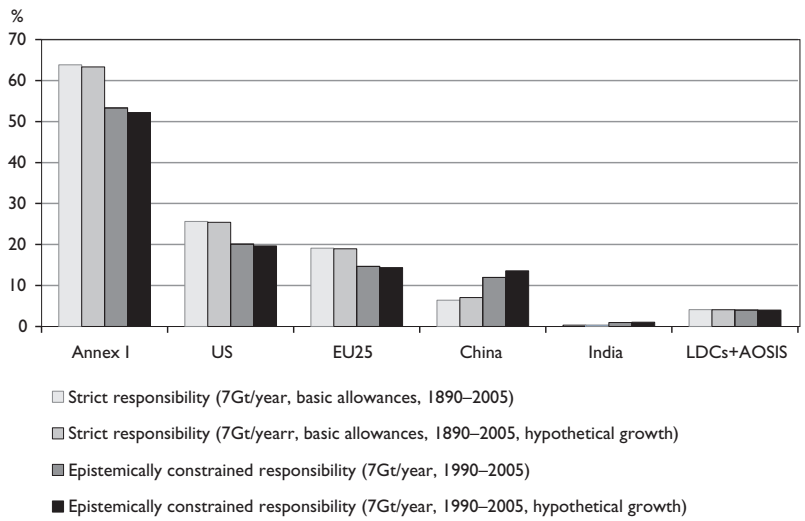
Mitigation through population control?

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 they 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.[17] Estimates on the size of the current population in the absence of the policies that were implemented vary, 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 the official 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 8.7 $GtCO_2eq$ instead of 7 $GtCO_2eq$ in 2005.

Figure 4.8 shows the new responsibility shares for a higher Chinese population and emissions growth under the assumptions outlined above. Note that the increase in the allocated share of basic allowances for the 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 percentage points), the USA (–0.2/–0.4 percentage points) and EU25 (–0.2/–0.3 percentage points) are lower in this hypothetical case. Interestingly, the responsibility shares of India increase by roughly one 10th (but still less than 0.1 percentage point) 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 (emissions from 1990

Figure 4.8: Hypothetical responsibility with faster Chinese population growth



Source: Authors' calculations based on MATCH dataset.

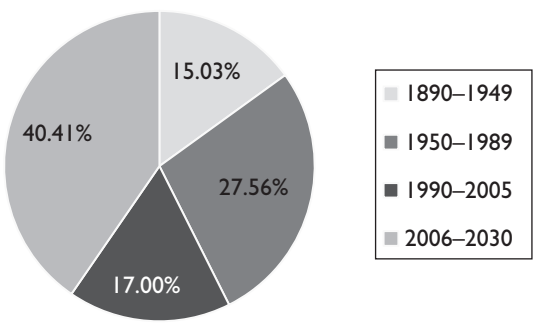
only) to 13.6% from 12%. With all the caveats noted regarding the assumptions underlying this calculation, it can be claimed that China hypothetically reduced its responsibility for climate change by 10% and 13.5%[18] respectively by means of population control.

Projecting responsibility into the future

China has undoubtedly started to implement numerous policies that have a climate change mitigating effect (Ellermann et al, 2009). In the deliberations of the 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 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 such as energy generation and heavy industry facilities. Decisions made in year 2010 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-cited year 2030) and its potential responsibilities – including historical (pre-2005) and new emissions – therefore seems to be warranted. Figures 4.9 and 4.10 corroborate this point, as in the MATCH dataset 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

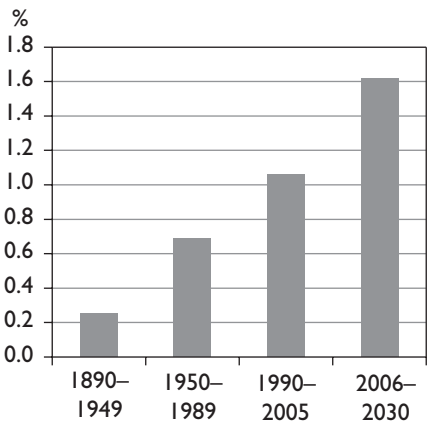
Figure 4.9: Total contribution during different time periods (MATCH data)



Source: Authors' calculations based on MATCH dataset.

available emissions data (2005) and extrapolated country emissions using an average of the six basic IPCC SRES (Special Report on Emissions Scenarios) 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 section is *not* to come up with a reliable number of future emissions, but to illustrate the potential future direction of responsibility for climate change. In contrast to the previous sections, this section 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* historical 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.[19]

Figure 4.10: Annual contribution during different time periods

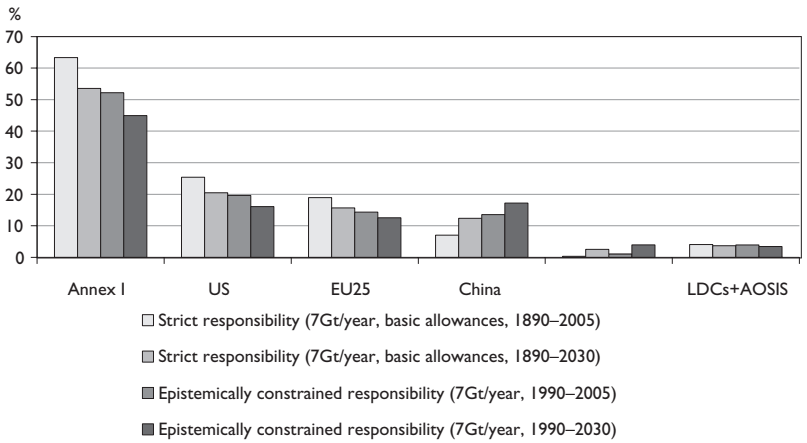


Source: Authors' calculations based on MATCH dataset.

The look into the future reveals potentially significant shifts in the shares of responsibilities of countries and regions (Figure 4.11, lighter colour shows actual historical responsibility, darker colour shows 'potential future responsibility'). Strict responsibility of Annex I countries would be 53.8% (–10.1 percentage points), epistemically constrained responsibility would be 45.2% (–8.1 percentage points). The shares of the US would decline by 5 percentage points to 20.6% and 3.9 percentage points to 16.2%, and EU25 to 15.8% and 12.6% respectively (–3.3/–2.1 percentage points). China's share of strict responsibility would rise sharply to 12.1% (plus 5.7 percentage points or 88.3%) and epistemically constrained responsibility would increase

by 4.8 percentage points (or 40.4%) to 16.8%, overtaking the potential shares of the US and EU25 and potentially amounting to more than a third of the Annex I total by 2030. India's potential responsibility shares rise to 2.6% and 4% respectively (2.3 percentage points/3 percentage points and a drastic relative increase).

Figure 4.11: A scenario for future (historical) responsibility for climate change



Source: Authors' calculations based on MATCH dataset.

The direction of these numbers – which as noted before should not be interpreted as an ethical analysis of future historical responsibility, but merely as a calculation based on commonly agreed emission scenarios – could potentially have significant implications for the ethical debate surrounding climate change. They point to the use of future emissions scenarios as an important research topic when looking at projected responsibility.[20] So far, there is no ethical concept for combining actual historical responsibilities and potential future responsibilities, and the calculations here cannot be used for their absolute numerical results. Their direction, however, suggests that by 2030, 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 by 2030 potentially become similarly responsible for climate change as the US or EU25, and India's responsibility could surpass that of Germany or Japan. This does not, however, affect the argument of limiting capabilities of current developing countries to combat climate change.

Conclusion

One aim of this chapter has been to put forward and discuss a methodology for the numerical differentiations of China's 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 historical emissions as a proxy. Moving to fully fledged climate modelling techniques as used in the MATCH project would change the relative contributions and resulting responsibilities by at most 10% for most countries.[21] Our aim was not to engage in a debate over 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 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 is large. Further thought needs to be given to how these calculations of historical responsibility can inform the debate around burden sharing, particularly given the discrepancy between the affluence and wealth of the exponents at either end of the spectrum of responsibilities we considered in this chapter.[22]

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 responsibility concept to include the most likely emission scenarios for the coming one to two decades. It is very likely that the responsibility of countries in 2030 will look quite different from today, and China's share will be hard to ignore by that time. Our ability to see this today raises interesting epistemic questions and points to the need for increased research on this matter, and particularly on the future of responsibility.

Notes

[1] Here we build on Müller et al (2009), giving particular attention to the role of China.

[2] In this chapter, the traditional definition of countries' 'anthropogenic' emissions, namely that from their sovereign territory, shall be followed, for determining both their relevant causal contributions and moral responsibilities.

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

[4] As Müller et al (2009) emphasise, the methodologies could easily be adapted to be used with the full MATCH modelling techniques.

[5] Ultimately, however, they use country-wide emission contributions, adjusted for 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.

[6] 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 that being given the legal licence to produce tobacco does not give one immunity from the consequences of tobacco use!

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

[8] The calculations that follow are based on data from a variety of sources (Klein Goldewijk and Battjes, 1995; Marland et al, 2003; USEPA, 2006; UNFCCC, 2007). See Höhne et al (forthcoming, section 2.1) for a detailed discussion of the emissions dataset.

[9] This percentage is in the same range as 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%.

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

[11] Based on the Chinese presentation at the AWG-LCA Shared Vision workshop at COP14 in Poznan in 2008. This simplified metric circumvents the problem that there is no logically meaningful expression of average per-capita and per-year emissions.

[12] Based on a side event at the 15th Conference of the Parties (COP15) to the UNFCCC in Copenhagen in 2009 (Pan et al, 2009). Note that Chinese

researchers are generally working only with energy CO_2 emissions rather than all gases and sectors in the Kyoto Protocol. We assume they did the same here.

[13] The data before 1890 are much less complete. Roughly 10% of the effect of total aggregate emissions is left out when starting in 1890 instead of 1750, the year normally identified as the start of industrialisation. See Höhne and Blok (2005).

[14] Strictly speaking, we should also have allocated basic allowances according to the terrestrial 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.

[15] 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 of the UNFCCC.

[16] See Müller et al (2009) for a full sensitivity analysis for varying choices of basic and subsistence allowances.

[17] It can be questioned whether 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 could have been hampered by overpopulation, leading to an elasticity lower than 1.

[18] Per cent, *not* percentage points.

[19] The question of the use of future emissions – modelled in emission scenarios – to calculate the historical responsibility at an end year that lies in the future would 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 and so on, and considered the modelled emission scenario an accurate description of future development, these future emissions could already be assumed to be historical today. Then they could be summed up with actual historical emissions.

[20] 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 1990-2010.

[21] Per cent, *not* percentage points.

[22] Affluence (GDP per capita, PPP, 2005): US = US$41,890, India = US$3,452. Wealth (GDP, PPP, 2005): India = US$3.8 trillion, US = US$12.4 trillion (World Bank, 2006).

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