Benefit-Based Framework for Climate Change Burden Sharing

Considering Population, Cumulative Emissions & Trade in the Past, Present, and Future

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Summary

Many agree that a long term goal of equal per capita emissions allowances for the entire global population is the most equitable outcome of reducing atmospheric greenhouse gas concentrations.

However, current UNFCCC negotiations do not appear to be prioritizing this outcome: there is no existing policy framework for achieving equal per capita emissions, nor is there momentum towards utilizing frameworks which would determine nations' emissions reduction responsibilities based on agreed-upon criteria.

While we recognize that imposing such a framework is difficult in a consensus-driven process, this structure is necessary for an equitable and objective-driven outcome. However, we posit that policy proposals that have outlined such frameworks are, to date, excessively narrow. Accounting for historical emissions legitimately implicates the current generation for their own past emissions, but also implicates them for emissions of bygone generations, which is overly simplistic. In general, we assume here that holding nations responsible for historical emissions, while allowing populations to grow globally outside policy consideration, is inconsistent and ultimately inequitable.

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For these reasons we have designed a new framework for considering entities' (ranging from individuals to nations) liabilities for intergenerational, global environmental problems utilizing two novel criteria: benefits received from an action resulting in an impact and the potential for future impact. The framework considers the timeframes during which the perceived benefit and the actions resulting in the impact have occurred, allowing one to systematically consider climate change liability for past, present and future actions including cumulative emissions, trade, and population growth.

Through our liability framework, we find that the current populace of nations with high cumulative emissions are indirectly liable for the harm those emissions will cause. Through similar reasoning, we determine that historically large and future population growth should not be culpable, per se, under an international climate agreement, but that nations or communities continuing to benefit from rapid population growth are indirectly liable for the future emissions that will result from higher populations.

In this paper, we discuss policy implications of this framework, including suggestions for extending the proposed liability framework into an emissions reduction allocation proposal which seeks to efficiently achieve equal per capita emissions limits in the long run.

Background

Equal per capita emissions on a global scale is often cited by climate policy stakeholders as the most equitable long term goal. Emissions reduction schemes for achieving equal per capita emissions are commonly discussed by academics. However, very few of these ideas have manifested in UNFCCC proposals. The Copenhagen Accord (2009) makes no mention of equal per capita emissions. Earlier UNFCCC proposals have outlined frameworks for determining each Party's responsibility for climate change mitigation, but have not demonstrated how equal per capita emissions might be achieved in the long term.[1]

Furthermore, **any existing frameworks are not sufficiently comprehensive because they either (1) lack distinction between the beneficiaries of emissions versus those who are emitting, (2) lack an explicitly stated definition of emissions liability, and/or (3) consider population only for determining resource allocations, but never from the standpoint of liability** (see Brazil Proposal 1997, Kyoto Protocol 1998, Corge-Morlot and Höhne 2003, Rive et al. 2006, Bali Action Plan 2007, AWG LCA 2008, Rive and Fuglestvedt 2008, den Elzen and Höhne 2008, Chakravarty et al. 2009).

Here we provide a novel framework which:

- *Provides a comprehensive understanding of culpability for intergenerational global environmental problems.*
- *Guides burden-sharing determinations among entities with liability for climate change impacts.*
- *Provides a long-term roadmap for achieving equal global per capita emissions.*
- *Supports development of a highly structured emissions reduction scheme applicable to a broad range of UNFCCC Parties (i.e. inclusive of both developing and developed countries).*

Principally, our work has implications for two controversial but important issues, one of which has fallen out of favor within international negotiations while the other has not yet been comprehensively integrated into the climate policy debate: cumulative emissions and population growth.

[1] Subsequent presentations on the Brazil Proposal highlight how global per capita emissions would converge over time. However, this is not clearly outlined in the original Proposal (den Elzen 2001, Brazil Proposal 1997). The Ad Hoc Working Group on Long Term Cooperative Action (AWG LCA) in its 2008 workshop on a shared vision mentioned the importance of several equity principles, including "equal rights to common atmospheric sources, and per capita accumulative emissions convergence," but no detail has been provided yet how these principles might be incorporated into agreement text (AWG LCA 2008).

Relevant Literature

Cumulative emissions

Developed countries have contributed most of the GHG emissions already in the atmosphere, especially CO_2 from fossil fuel combustion (den Elzen et al. 2005). The current populace of developed nations have benefited from these past emissions, even if they had no say or role in their generation, because of the economic growth, technology and development that resulted. **An equitable international climate policy would reasonably consider a nation's cumulative emissions. This idea is embodied in the UNFCCC's principle of "common but differentiated responsibilities".** However, current proposals for considering cumulative emissions systematically are excessively narrow in their scope of criteria for determining responsibility for emissions reductions.

The Brazil Proposal

The Brazil Proposal, which was proposed in 1997 during the Kyoto negotiations but failed to gain traction, **assigned a nation's liability for cumulative emissions based on the impact of those emissions on sea-level rise and global temperature rise**. This framework legitimately implicates the current generation of a nation for their own past emissions, but also implicates them for emissions of bygone generations, which in our view is overly simplistic for several reasons.

- Firstly, both current and historical emissions can have benefits outside the country where they were produced. The Brazil proposal flatly assigns emissions liability to the nation that generated the emissions, even though some of the benefits from technology transfer, trade, and aid that resulted from the emissions may have been shared with other nations.

"Accounting for historical emissions as a sum of emissions over a nation's history is inconsistent with how we consider other factors that impact climate change, like population growth."

- Secondly, a significant portion of historical emissions are only indirectly connected to the present generation, creating a sense that present emitters in developed countries are being "punished" inequitably for something they did not cause (Rose, 1990).

- Thirdly, **accounting for historical emissions as a sum of emissions over a nation's history is inconsistent with how we consider other factors that impact climate change**. For instance, increasing population size within a nation has typically contributed to increased resource use and larger net national emissions (Shi 2003). Climate change proposals do not fault the current generation for its current population size, since they did not have control over the decisions which allowed the population to grow, and thus for the role of population growth in driving up national emissions. It is similarly unacceptable in our view to consider the current generation fully responsible for emissions that they had no role in generating.

The circumstances under which present entities can be held responsible for these emissions must be more nuanced in order to improve consistency and fairness. Our framework seeks to elucidate the circumstances under which a present entity can be held liable for past actions which she did not directly cause but which nevertheless result in an impact.

Population growth

> *"The circumstances under which present entities can be held responsible for past emissions must be more nuanced in order to improve consistency and fairness."*

At present, population growth and population policies are not considered in climate policy, despite potentially significant effects. Population growth can result in increased emissions, abstraction of per-capita emissions limits, or both. Population reductions or stabilization can reduce emissions increases. Most growth is occurring in developing countries, but also in some developed nations – such as Australia and France, where strategies have been proposed or implemented to encourage population growth for economic reasons (Symons-Brown 2010, Grant et al. 2004). Emissions increases are desirable for developing countries with large impoverished populations, given that 2.7 billion people in 2030 are expected to emit less than 1 tCO_2/year, which is far below even a theoretical equal atmospheric carbon allocation (Chakravarty et al. 2009). However, huge disparity in emissions within nations can undermine the argument that emissions increases are needed when populations grow, if the resulting emissions are not benefiting the growing poor population.

Common but differentiated responsibility for individuals

Population size and demographics have been indirectly addressed through a few emissions reduction schemes. Chakravarty et al. rely not on historical emissions, but rather current per capita emissions at the individual level to determine a nation's emissions reduction responsibility (2009). Based on a global emissions distribution and a global gross emissions limit, under this framework approximately 1 billion high emitters are implicated for their excessively high emissions. "Common but differentiated responsibility *for individuals*" posits that a nation's emissions reduction responsibility is determined by its number of high emitters. The proposal also includes a per capita emissions floor, such that a nation's lowest emitters may grow their emissions without impunity.

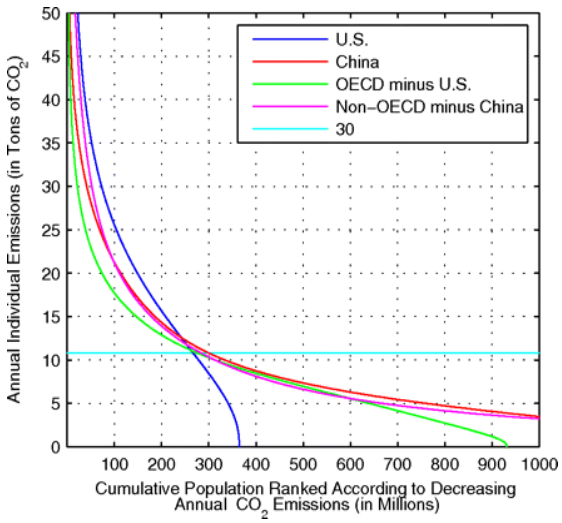


Figure 1: National emissions distribution (from Chakravarty et al. 2009)

This framework upholds the equity principle of treating all high emitters the same, regardless of location, thereby not allowing individuals benefiting from actions that cause high emissions to "hide" behind the low per capita emissions of their compatriots. In this way it also considers population and emissions growth rights more equitably than proposals that do not implicate developing countries at all.

Thus far, population has been included in climate policy proposals only to the extent that it influences the calculation of per capita emissions or emissions demographics, and rarely as it affects long term per capita emissions allocations. It has not yet been included as a potential source of liability for climate impacts, though, as we have stated, growing populations can lead to emissions growth and thus climate impacts both through increasing per capita emissions and increasing gross emissions with constant per capita emissions.

Including population changes in burden sharing determinations is more complicated and controversial than is incorporating current and cumulative emissions. **It is much more intuitive to hold the current generation responsible for historical emissions than to assign responsibility for climate change for past, present or future population change.** Both are driving forces of over-use of the atmosphere as a carbon sink, though the main differentiation is that past emissions growth has typically allowed for development of the economy, institutions, infrastructure and technology which continues to benefit the current generation. Population growth does not *always* have such an effect and, if it is beyond certain ecological and/or economic limits, can result in negative economic growth per capita (Crenshaw 1997, Bloom 2003).[2] However, as noted above, there are economic and other incentives to reproduce and otherwise grow populations at both the individual and the national level.

"Accommodating both cumulative emissions and population growth as sources of liability for climate impacts under one burden-sharing framework requires that climate change liability be based on **benefit** *received from a given action which results in an impact."*

Accommodating both cumulative emissions and population growth as sources of liability for climate impacts under one burden-sharing framework requires that climate change liability be based on *benefi*t received by the current generation for a given action which results in an impact.

Basing liability on benefit

The framework proposed here bases responsibility for climate change on the benefit received from actions resulting in climate change. This allows us to do two important things previously unaccounted for in earlier frameworks:

(1) Provide a clearly defined foundation for holding the present generations liable for past emissions: **the present generation is not liable for *all* past emissions, rather only for those *from which it has gained benefit*.**

(2) Implicate entities for present actions from which they gain benefit which result in climate impacts, including increasing population size.

We hold that the benefit-based definition of liability allows for more comprehensively implicating entities in climate change impacts and is inclusive of a broader range of entities compared to previous frameworks. Additional support for the benefit-based definition will be discussed in the Methodology as the structure of the framework becomes clearer.

[2] However see Hasan 2010, Thorton 2001, Becker et al. 1999, Dawson and Tiffin 1998 which state that the relationship between population growth and per capita income is dependent on several factors, including population age structure, government policies that may or may not capitalize on an enlarging work force and whether the gains from the increase in human capital offsets possible diminishing returns from natural capital.

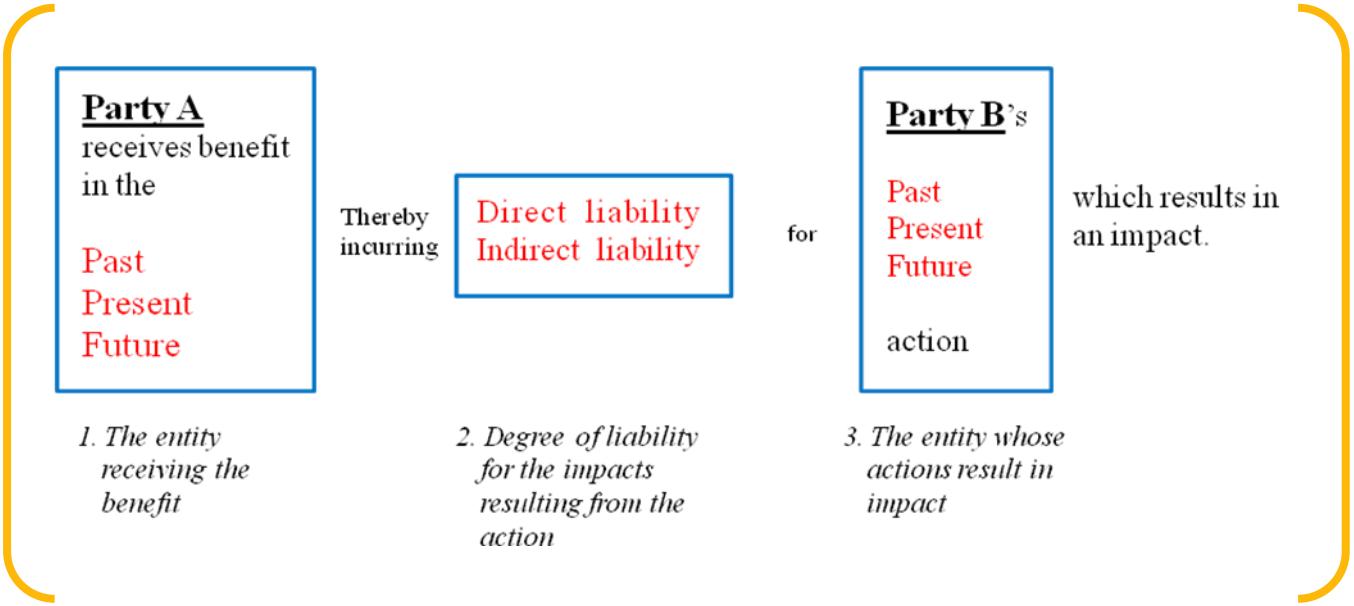
Methodology

A general framework for liability-adjusting policies

This framework is intended to help policy makers consider the issue of environmental liability in a more structured and expanded manner than has been employed to date. There are three relevant parameters for determining liability for policy adjustment accounted for within our framework:

1. The entity which is responsible for the action's occurrence (Party B below, e.g. a country emitting GHGs over a sustainable limit)
2. The entity receiving the benefit of an action resulting in an impact (Party A below, e.g. the same country as Party B, a neighboring country, trading partner, etc.); and
3. The time difference between when the action occurred and when the benefit was received (if any), which determines whether the liability can be directly or indirectly attributed to Party A.

We can assume that Parties A and B are rational actors and therefore only undertake actions which are beneficial to themselves. This means that, for example, we can assume that any historical GHG emissions of an entity were the result of transactions which benefited and may continue to benefit that entity. The model is capable of considering liability for actions resulting in, anticipated to result in, or that have already resulted in an impact.



Important points to note:

- "Party A" and "Party B" can represent the same, or different, entities. Generally, if Party A and Party B are the same entity, she is directly liable.[3]
- Past, present, and future refer to general timeframes, their definitions depend on the context of the issue being considered.

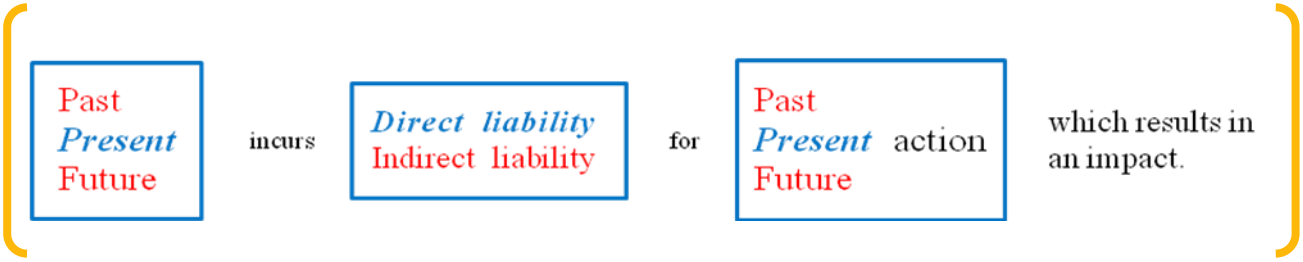
[3] Thus if Party A and Party B are different entities, Party A generally has indirect liability, unless Party B's activities resulting in impact have been contracted by Party A. This is discussed further below.

- The degree of liability (direct vs. indirect) is not determined by the difference in time between action and impact, but between action and benefit.
- Any actions causing a future impact that is considered to be "actionable," or of high enough risk to warrant preventative measures, should be included in the liability analysis.

For example, we might consider that a policy passed through a national legislature today to increase coal production would create present liability for an expected future impact. The difficulty faced in determining the magnitude of impacts – particularly future impacts – supports our use of "benefit" as the metric for assigning liability. Examples below make an effort to clarify some of these definitions.

Case examples:

(1) *Present "Party A" incurs direct liability for "Party B's" present actions resulting in an impact*

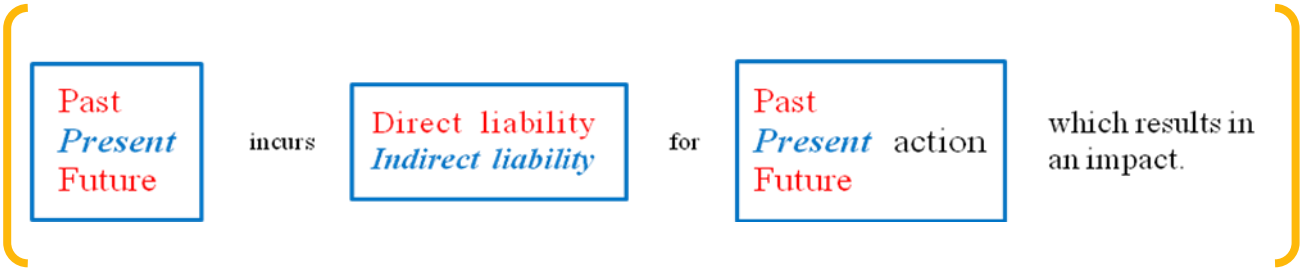


Assuming an equitable emissions limit of 1.7 tons C·capita^{-1}·year^{-1} were implemented globally, individuals in the United States would be implicated for presently emitting above that level (here Party A and Party B are the same entity). The liability statement would be framed as follows:

> *An individual currently living in the United States incurs direct liability for the climate change impacts caused by her emissions of greenhouse gases beyond sustainable per-capita levels.*

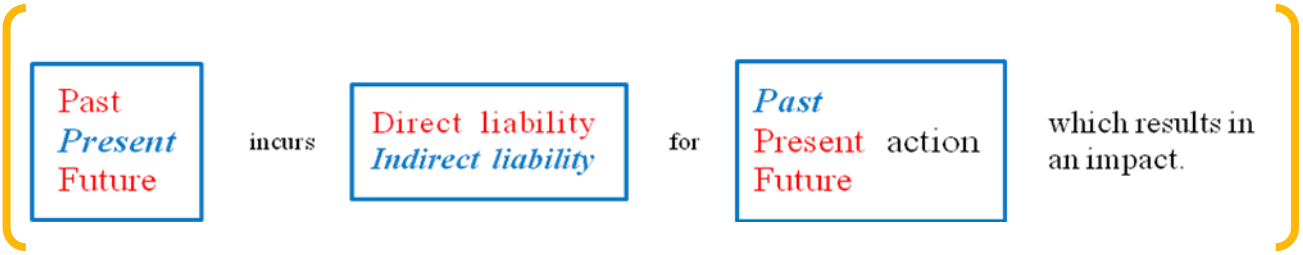
Similarly, and more relevant to international climate policy, the United States as a nation has direct liability for the emissions of its present populace beyond sustainable levels based on the size of its populace and the per-capita allowance.

(2) *Present "Party A" incurs indirect liability for "Party B's" present actions resulting in an impact.*



The framework is also capable of considering the environmental harm that is externalized through trade. For instance, a present-day individual in the United States benefiting from the use of consumer goods products manufactured in China has indirect liability for the climate change impacts caused by China's present emissions used to produce and transport the good. This becomes more complicated when the product consumer contracted the product's production, rather than acquiring it off the market. This concept is discussed further below.

(3) ***Present "Party A" incurs indirect liability for "Party B's" past actions resulting in an impact.***

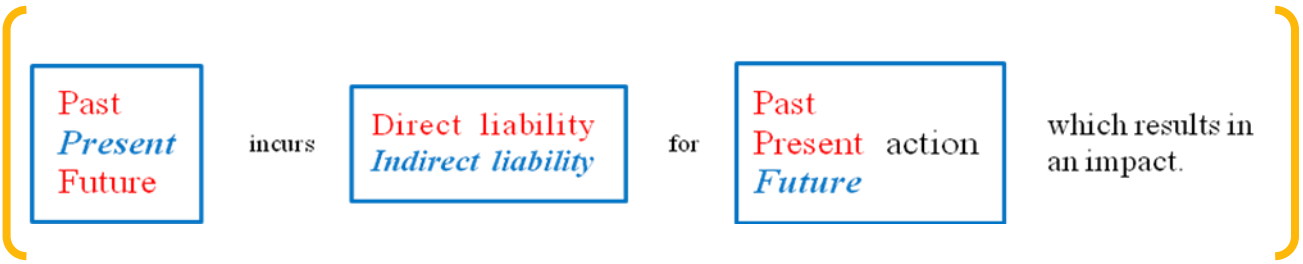


A present individual in Mexico benefiting from the use of a wind turbine developed in Germany has indirect liability for the climate change impacts caused by Germany's past emissions that occurred as a result of developing the wind turbine technology. Thus technology transfer's benefits to Party A (buying the technology) implicates that party with some of the liability from the emissions resulting from Party B's development of that technology. This is broadly applicable to many developed countries which emitted carbon to develop technologies widely used around the world today.

We acknowledge that measurement of "benefit" is hugely subjective – ranging from GDP growth to psychic satisfaction – and that the method of determination is ultimately a political decision. However, once such a decision is made, the framework allows calculation of liability to occur in a structured manner.

Indirect liability for past actions also applies to cumulative historical emissions. For example, the combination of a large population and high emissions makes the U.S. the largest cumulative global emitter (IEA 2007, pg. 201). Assigning liability for these historical emissions has been a contentious issue but can be dissected in this framework. Firstly, we consider "past" U.S. emissions as occurring from the Industrial Revolution to the present generation. The present population of the United States had no control over the actions or decisions of the bygone generation, thus the present generation cannot be assigned direct liability. However, the present generation has benefited significantly from the development, infrastructure and increased welfare that resulted from these emissions. Therefore the present U.S. populace whose welfare has increased from the economic development of the past is indirectly liable for those development-related emissions.

(4) ***Present "Party A" has indirect liability for "Party B's" future actions resulting in an impact.***



Applying the framework to population is trickier but still effective. Australia's proposed policy to increase population over several decades to stimulate the economy could, for example be met with policy impunity. Australia's increasing population strains global resources, and would have been, under the recently abandoned 'Big Australia' policy, a conscious decision on the part of the government to accept

economic benefit in exchange for higher emissions (Symons-Brown 2010). The beneficiary of the policy is Australia itself, thus it incurs the emissions liability that results.

As proposed, the model can determine if there is liability, but cannot give a measure of the magnitude of the liability for an activity resulting in an impact. This framework does suggest that indirect liability carries less consequence to the liable party than would direct liability. We are not viewing the term "liability" as a measure of fiscal responsibility or required carbon dioxide reduction, as may be common in legal definitions. Rather, we perceive an entity's "liability" as a fraction of total global liability which is the summed responsibility of all global entities to address climate change. An entity's liability would be calculated in reference to others – and to the global total. This concept allows us to implicate actors in global, intergenerational problems which is especially important now for building equitable climate policies.

Policy Implications

Share liability for trade emissions

The liability framework requires considering who benefited from an action which resulted in climate impact. By attributing liability from the production of goods or services which are exported to both the importer and the exporter, we take into account the benefits of trade-related emissions to both the importing and exporting entities.

However, sharing emissions liability from the production of traded products does not account for all indirect and direct beneficiaries to past and present trade emissions, such as, for example, technology transfer. Current commodities trade is a relatively implementable place to start.

Only hold present entities liable for past emissions from which they gained welfare

We have defined present, indirect liability for past actions as being limited only to those actions from which the present populace or individual has gained welfare. Therefore, if an emissions reduction allocation scheme is accounting for historical emissions, the liability framework states that the present emitter can only be held liable for those historical emissions from which she has gained welfare.

But how does one detect welfare gain from past emissions, thereby determining which emissions the present emitter is liable for? First, we can arbitrarily define 'since the previous generation' as within the past 50 years. Next, one strategy to define 'welfare gain of the present generation from past actions' is to use level of GDP growth since the previous generation as a proxy for human development.[4]

One could argue that for the present population to be indirectly liable for a given bundle of emissions that were emitted at some known point in the past, that bundle must have been emitted as a result of an activity that eventually led to an increase in GDP experienced in the current economy. But, again, how can we know which past emissions were a result of activity that has directly (or indirectly) led to current GDP growth? Given the complexity of transactions in a national economy over time, perhaps any past economic activity (and its resultant emissions) could be implicated. For a country

[4] Though the relationship of GDP growth to human development is not always reliable (Sagar and Najam 1998, Sen 1999, Daly and Farley 2004, Catton 2009), GDP per capita has been used for climate policy modeling (Catton 2009) and is generally an important indicator of increasing well-being (Aturupane et al, 1994; Ranis et al. , 2000).

like the US, which has experienced largely uninterrupted economic growth since the 1930s, this may very well be so. However, it seems unlikely for countries in which economic growth has been erratic.

There is room here for research on how to achieve more accurate estimates of current liability for past emissions.

Incorporate population growth management in emissions reduction strategies

Assigning present liability for future actions requires an analysis of where current actions and choices can result in future emissions growth, namely growing per capita emissions or growing population with constant or growing per capita emissions.[5] For those entities for which population will unavoidably grow (due to high fertility rates and/or population momentum), or who promote further population growth through policy, the emissions implications of this growth would be incorporated into their present liability for future actions. Below we propose a concept which integrates our liability framework into emissions reduction accounting.

Person-emissions

In order to incorporate population into the formulation of entities' emissions reduction responsibilities, we introduce the concept of 'person-emissions.' This concept replaces and is of equal quantity to an entity's 'total annual emissions' but incorporates the element of the individual as a consumer and therefore a driving force behind emissions. An entity's total person-emissions is calculated by summing the emissions of all inhabitants or members of the entity.

$PE_{Xt} = \sum_{t=1}^{x} e_{Xt}$ where

PE_{Xt} is the total person-emissions of entity *X* at time *t*
e_{Xt} is the total emissions attributable to individual *n* who is a member of entity *X*

The figure below shows how the person-emissions concept is used in calculating an entity's (here, the US's) 'sustainable person-emissions allocations' and thereby the historical point at which an entity can begin to incur indirect liability from excess emissions. It also serves as a long term goal for achieving global equal per capita emissions.

Sustainable person-emissions allocation

An entity's sustainable -emissions allocation is determined by multiplying the global sustainable per capita emissions limit by that entity's population:

$SA_{Xt} = (\frac{GL}{P_{Gt}})P_{Xt}$ where

SA_{Xt} is the sustainable person-emissions allocation for entity *X* at time *t*
GL is gross global sustainable annual emissions limit (a constant)
P_{Gt} is global population at time *t*
P_{Xt} is population of entity *X* at time *t*

[5] There are others, not discussed here, such as trade policies which are expected to increase consumption and therefore emissions.

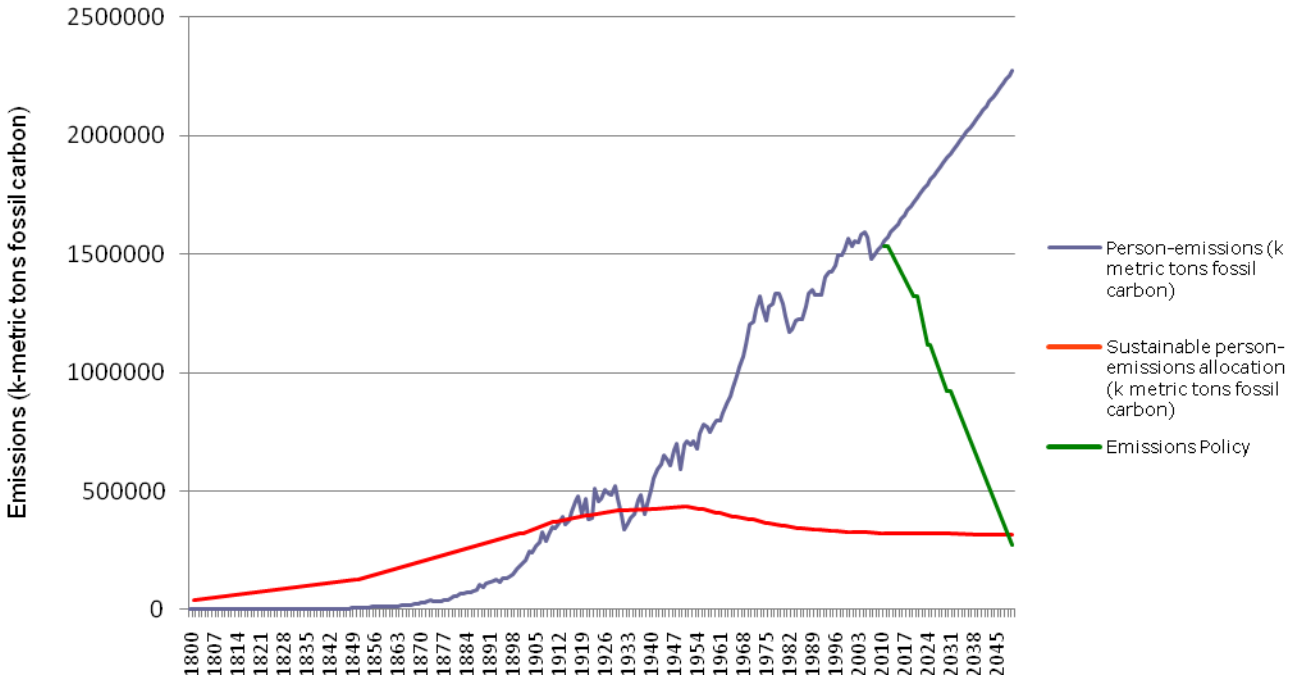


Figure: US Sustainable person-emissions allocation and total person-emissions with US proposed 'Emissions Policy' commitment of 17% reduction from 2005 levels by 2020 and 83% reduction from 2005 levels by 2050.[6]

PE_{US} first exceeds SA_{US} between 1910 and 1920, then again between 1923 and 1935, 1938, and then from 1939 on. Under our framework, the present US population is indirectly liable for any of these 'past' emissions exceeding SA_{US} from which the present US population has gained welfare, and directly liable for any 'present' emissions.

Utilizing the 'person-emissions' concept is a possible strategy for including population growth management in emissions reduction goals. Entities can set reduction goals for both per capita emissions and population growth to contribute to meeting 'person-emissions' reduction responsibilities.

The per-capita allocation policy provides a perverse incentive for an entity to grow its population in order to garner a greater sustainable person-emissions allocation. This is especially a problem when the population growth occurs amongst the lowest emitters of a country, which can shield the nation's high emitters from reductions. Since the incentive could not apply retroactively, historical population could change dynamically in the calculations just as it is described above. However, future population size of an entity (P_{Xt}) could be set as some constant future steady-state population, with the time gap allowing for expected growth from population momentum and for current population growth rates to readjust to policy incentives.

Utilizing 'person-emissions' reduction goals and sustainable person-emissions allocations makes global equal per capita emissions the default long term goal for all entities included in the emissions reduction allocation scheme. The long term goal would be for each entity to have PE_X equal to SA_X, or equal average per capita emissions among all entities.

[6] Based on fossil-fuel CO_2 emissions only, assuming 7 billion metric tons is sustainable annual global limit for fossil fuel CO_2 emissions (Boden et al. 2010, UN Population Division 2009, Gibson and Jung 2002, UNFCCC 2010a). Projected BAU emissions from 2007-2050 based on linear extrapolation of 1982-2007 emissions.

Conclusions

We have proposed a novel structure which uses benefit from an action resulting in emissions as the means of determining emission reduction liability. Liability – as we use it – is also a new concept, where the liability of every "entity" sums to total global liability and thereby allows us to calculate each entity's proportional required emissions reduction. Additionally, the methodology section of this paper discusses the importance of the timeframe in which the emission occurs, as well as the timeframe in which benefit to the liable entity was received. This conceptual aid can help to determine the magnitude of emission liability, though it is not possible to calculate total liability from the framework as it stands. The policy implications section has suggested new methods of considering population and emissions liability, through correlating historical emissions with GDP growth and incorporating population management as a climate mitigation strategy.

The framework is applicable to other global, intergenerational environmental problems, such as ozone depletion, deforestation, and resource exploitation. Climate change was used as the foremost example given the immediacy of the international dialogue, and the implications of our population and cumulative emissions findings. We hope further research will clarify the framework's use for other environmental problems.

In the context of climate change, we believe the liability framework should be used to determine where liability for emissions will be assigned, and thus which entities will be responsible for fulfilling emissions reduction requirements. We recognize, however, the political reality that the liable entity will not necessarily be the entity that pays for the infrastructural and technological changes required for the reductions. Rive et al. has shown that similar frameworks such as the Brazil proposal and Rive and Fugelstvedt proposal violate ability-to-pay principals for many developing countries (2006, pg. 189). **Instead of requiring lower emissions reductions from the countries which cannot afford their emissions reduction allocation, the funding should come from an external source.** Population growth management may also reduce the costs of emissions reductions for developing countries, though the economic costs and benefits would have to be determined on a case by case basis.

Furthermore, requiring emissions reductions from all entities is likely key for ensuring progress in the UNFCCC negotiations. The liability framework we have discussed may give more reticent Annex I countries (e.g. the US) a constructive tool or 'ask' in the negotiations. Under the proposals put forth thus far, developed countries are essentially backed into a corner as the sole bearers of climate mitigation responsibility. Accounting for present liability for future actions may require more stringent but achievable commitments from developing countries, which could appease countries like the US.

We recognize that the concepts presented in this paper could be perceived as an effort to reduce the cumulative emissions responsibility of particular entities – namely developed nations – or to implicate developing nations for their fast growing populations. **However, we emphasize that we are unsure of the net effect of the framework for any single entity or nation, because the framework has many variables with metrics subject to political and scientific measure. We hope the framework will be a constructive tool in the negotiations, as opposed to a strategy of tit-for-tat political posturing and unambitious, incremental progress.**

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