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DRAFT

Abstract

Funding a response to climate change after Kyoto will require another look at both burden sharing and funding mechanisms. After reviewing the risks of cap-and-trade with carbon offsets and the advantages of a harmonized carbon tax, a method is proposed to utilize a harmonized carbon price to finance the Green Climate Fund. A common carbon price is set across all nations with either a carbon tax or an emissions trading floor price with carbon offsets excluded. The harmonized carbon price is incrementally increased until 2050 to reach the cost of atmospheric removal and achieve equilibrium. Carbon revenues collected internally within nations are used for internal investments in climate change. Financing for the Green Climate Fund is generated from transferring a percentage of the collected revenues, based on a sliding window of historical responsibility for fossil fuel emissions and national wealth. Collected revenue is disbursed for climate aid based on a set of national climate need factors for adaptation and mitigation, including preserving strategic carbon absorbers, low-carbon infrastructures, technology transfer and population management. In the interest of distributive justice, nations themselves determine the need factors of each other. Unlike cap-and-trade, this method does not explicitly set emissions caps, but total global emissions can be regulated nevertheless. Formulas are presented for collection and disbursement, which require parameters for a globally harmonized carbon price, a climate fund contribution rate, historical responsibility from fossil fuel emissions, a national wealth threshold for fund contributions and need factors for each nation. Published economic and emissions data are used with the formulas to demonstrate an example of how the financing can work. This presents an equitable way to address climate needs across all nations on both a global and regional level.

JEL: E01, F18, F35, F51, F53, Q54, Q56

Keywords: climate change; global warming; green climate fund; carbon tax; cap-and-trade; climate finance; Kyoto protocol

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1. Introduction

Efforts to develop a truly effective global carbon emissions treaty have proven to be very difficult. Key challenges are not only how to limit carbon emissions, but also how to fund this process globally. Unfortunately, the climate is not a linear system where differences can be split down the middle like a budget might be. Rather, the climate is more like a dynamical system, which accelerates between stable states. A large body of growing evidence suggests that the global climate is being pushed out of equilibrium, and at some point global warming will accelerate to the point of being unstoppable until a much warmer stable condition is reached. Since 1950, the average surface air temperature has increased by more than 0.5° C, with at least 74% from human activity (Huber & Knutti 2011). Current best estimates indicate present atmospheric CO_2 concentrations are already enough to cause a 2 °C rise in global temperatures (Schwartz et al. 2010). Global warming is likely to accelerate given positive feedback and as natural global heat and CO_2 absorbers shrink. Temperatures are rising faster at the poles, triggering the release of methane from the permafrost. Between 2003 and 2007, methane emissions from the Arctic increased by 31% (Bloom et. al. 2010) and could cause substantial positive feedback (Schuur 2011). CO_2 levels have not been as high as current levels since 15 million years ago, when the climate was very different and global average temperatures were 3-6 degrees Celsius higher than they are today (Tripati et. al. 2009). Additionally, the global climate sensitivity to atmospheric CO_2 levels as estimated in the 2007 Intergovernmental Panel on Climate Change (IPCC) report are now considered to be on the low end. Each year, human beings burn carbon that took nature hundreds of thousands if not millions of years to sequester, thus there really is no way to sequester our way out of this with carbon offsets. Carbon emissions have to drop substantially. Carbon offsets purchased from developing nations are not likely to significantly reduce global emissions, because offsets can be used by purchasers to continue polluting at the same levels (Den Elzen & Höhne 2010). While equilibrium emissions of nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride may be attainable in the foreseeable future, equilibrium emissions of CO_2 and methane are much more difficult. However, it is necessary to get CO_2 and methane emissions down as quickly as possible.

The dangers of climate change are something the human race has never faced before. Human beings have mostly evolved to respond to near immediate threats while also seizing opportunities in small groups. Climate change is quite different, because it is a slowly developing threat that affects the entire globe. World War II lasted six years and had serious repercussions for decades. But climate change is on a geological time scale, and actions taken in the next few years will likely have repercussions for thousands of years to come. Failure to act has the potential to cause more human suffering than the world has ever known. Yet, we collectively are not taking the risks seriously. The main problem is that countries and corporations are all seeking self-interest, creating an intractable solution space, even as time becomes short. A new approach is required, because not even enlightened self-interest is enough now. While a solution does likely exist, enlightened global-interest will be needed to find it. This is because the best or perhaps only solution may be one that few countries want directly.

Among other things, the Kyoto protocol (United Nations 1998) established some rules for sharing the burden of climate change impacts, as well as mechanisms to begin limiting carbon emissions. While Kyoto has made valuable contributions, it has two serious flaws. First, it did not fully consider the rising emissions from developing countries as living standards improve. Second, it is based primarily on emissions caps and trading. Emerging and developing countries favor Kyoto because it does not require them to establish binding emissions limits, establishes "common but differentiated responsibilities", and provides some funding through the Clean Development Mechanism (CDM) and Joint Implementation (JI) mechanisms. However, the US signed but never ratified the treaty, the only one of 192 signatories to do this. From the US perspective, this was mainly because emerging nations are not required to limit emissions, even though this is where most of the emissions growth is occurring. It also puts the US at a competitive disadvantage with emerging economies such as China. With only 27% of emissions bound under Kyoto until 2012, and with no limits for the US and China, countries with binding emissions limits do not want a second commitment period. It is also becoming increasingly clear that Kyoto in its present form cannot accomplish what is necessary to prevent catastrophic climate change. It was not designed to scale across all countries at different levels of development. Further, for most countries, carbon pricing via a carbon tax is sufficient and much easier to implement. It should not be required to implement a carbon market or be subservient to one in another country. The voluntary pledges from the Copenhagen and Cancun agreements are nowhere near sufficient to stay within 2° C (UNEP 2010; Rogelj et al. 2011), and are projected to lead towards a warming of 3.5° C (Höhne et al. 2011). Not only are the emissions reductions too low, but voluntary pledges will not create the dynamics necessary for a transformation of the energy infrastructure. And with a growing plethora of funds, this approach will ultimately lead to fragmented capital investments, inefficiency and redundancy. None of the existing approaches are not enough, because despite all current efforts, emissions from fossil fuels have already increased 49% since 1990 and 5.9% in 2010 alone (Peters et al. 2011).

Some countries are interested in creating a new treaty, binding all but the least developed nations to emissions limits. But the EU and others may want to delay completion of negotiations until 2016, for a treaty to take effect in 2020. Other than to stall painful budgetary action, the main impediment driving this delay appear to be to formulate a global cap and trade system and wait for emerging nations to reach peak emissions levels. This thinking requires establishing baseline industrial emissions in most countries to determine what the initial caps would be. But this creates a new set of problems. 2020 is too late to prevent serious damages to the most vulnerable countries and even 2017 is the latest date to begin economical transformations of the energy infrastructure (IEA 2011). Carbon markets are at best unproven, even 14 years after Kyoto was signed. Making a complicated unproven system even more complicated entails serious risks. There is perhaps one more chance to adopt a workable global treaty before it is too late and this has to happen quite soon. It simply is much too risky to wait and then bet the planet on carbon trading.

The goal of a new treaty should not be reaching a fixed global emissions limit, but rather achieving an atmospheric equilibrium of greenhouse gases at a low enough temperature to avoid substantial damage. As is obvious with Kyoto, fixed emissions caps are too limiting, particularly in developing countries. Ultimately, an emissions cap limits supply and produces a carbon price, which can fluctuate. As a corollary to this, a specific carbon price can also limit emissions by making it more costly. Some have argued that emissions certainty is better than price certainty because it can be bound within environmental limits. Except that the emissions limit itself is uncertain, because of uncertainty in the climate science and predictions of positive feedback. Plus, extra carbon allowances, carbon offsets and fraud make the true emissions levels even more uncertain. This means that the emissions caps would have to be constantly adjusted, not just incrementally lowered for reducing emissions. And with multi-year allowances, this would become very difficult to adjust. So ultimately, emissions caps in a global cap and trade system would have to be dynamically tuned on a global level, while differences are measured between actual emissions and the evolving environmental limits. Considering this, it would be far easier to just tune a globally harmonized carbon price instead. A huge advantage here is that a harmonized carbon price can be set quickly while measurement, reporting and verification (MRV) systems fall into place over time. Consider that the province of British Columbia in Canada implemented a carbon tax in just 5 months after passing legislation. Australia will do this too in less than a year after passing legislation. Fast action does not need to have technical limits, unless it involves carbon markets.

A new treaty can provide some of what the developing world wants, such as "common but differentiated responsibilities" and funding via the GCF without carbon colonialism, but it would have a cost. Namely, carbon would have to be priced globally, with revenues used for sustainable development and achieving an atmospheric equilibrium of CO2. In particular, the wealthy in developing nations would have to pay a carbon price, as well as people in developed nations. Although "common but differentiated responsibilities" leaves much to interpretation, it can be decomposed into responsibility for cumulative historical emissions (polluter pays) and national wealth (ability to pay). This is because when historical emissions and GDP per capita are highly correlated, the likelihood is greater that national wealth is a resulting benefit from fossil fuel consumption. Fossil fuel consumption also produces climate damage liabilities from carbon emissions, so nations that benefit more from burning higher amounts of fossil fuels should have higher burdens on these liabilities. Each emitted ton of CO_2 raises the social cost and damages of subsequent emissions, because it accumulates in the atmosphere with a half-life of about 31 years, further increasing temperatures. The higher the temperatures, the higher the damages. If the global climate was a linear system and each quantity of CO_2 caused a fixed incremental change in temperature, damages from these emissions would increase exponentially, since current emissions are much higher than decay. But considering that the global climate system is highly non-linear and is already becoming less stable, damages from emissions are likely to increase faster than exponentially.

Several studies by UNFCCC, World Bank, Stern, Oxfam, UNDP and others have sought to assess the total global costs of damages from climate change over time, using integrated assessment models (IAMs) and other economic models (Parry et al. 2009). The differences between damages with and without adaptation expenditures can be used to estimate the net present value of adaptation investments, with an appropriate discount factor. But these estimates are over a wide range and have serious limitations since some damages can be very difficult if not impossible to monetize. A changing average temperature can require an ecosystem or habitat to migrate to survive. But, when boundaries exist such as a sea, mountain range or desert, a habitat can be driven to extinction or experience major losses in biodiversity. Adaptation assumptions and discount factors are largely speculative, but can have large effects on outcomes (Ackerman et al. 2009). However, for the sake of discussion, let's assume the UNFCCC (2007) study is in the right range, estimating that $49-171 billion is needed globally per annum by 2030 for adaptation alone. That's a mean of $110 billion annually, which will continue to increase over time without mitigation funding to also reduce emissions and stabilize atmospheric concentrations. And without adaptation funding, climate damages are estimated to be 10x higher by 2060 (Parry et al. 2009). Consider that if the de facto liability for climate change damage is based on historical emissions, then the proportion of national liabilities from the total global climate damage could intuitively be based on a national percentage of cumulative global emissions. This means the US would likely have the highest burden in funding a climate change response, because it presently has the highest historical responsibility. So, why would the US participate in a global climate treaty when it might appear to be less costly to avoid it? Just considering the accumulating global liabilities from a US contribution of 26% of total historical emissions (1950-2007) from fossil fuels, these liabilities might be reduced by contributing roughly a factor of 10 less into the GCF. In addition, as a minimum, to not engage in a treaty would result in a loss of good will, less political influence, a weak internal market for green technologies, loss of trade exports, higher dependence on fossil fuels from both national and international sources and higher internal damages from climate change.

Still, there is a serious problem if emerging or developing economies do not have to set a price on carbon or establish emissions limits. Not only is it fundamentally unsustainable, but emerging and developing economies are already contributing more than half of global emissions. Establishing a new treaty may come down to negotiating acceptable burden sharing rules, with each region asserting rules which favor them most. Emerging economies often discuss burden sharing based on equity, or emissions per capita. But this will not work, because key factors in emissions growth are fossil fuel driven development and population growth. If those cannot be controlled, then climate change cannot be controlled at all. If the entire world had European 2003 level emissions per capita, the planet only has a sustainable level of 2-3 Billion people (Desvaux 2007), which is about the world population size in 1950. Using emissions per capita can also actually encourage population growth and poverty, because a higher population size living in poverty translates into a lower emissions per capita. And already, inequity within emerging nations is perhaps higher than anywhere else. Because of higher productivity, the US may favor emissions by unit of GDP. Russia favors emissions by land area. (Ringius et al. 2002) But, the real issue is the carbon emissions itself, wherever it occurs. The approach considered in this paper is to adjust burdens based on carbon emissions, taking into account historical responsibility and national wealth.

Basing burden sharing at least partly on carbon emissions requires setting a carbon price either directly or by imposing limits. IAMs and other methods try to establish the economic impact or social cost of carbon (SCC). Estimates of SCC have a large variance and high uncertainty. Some consider the economic models to provide weaker estimates than the more robust climate science models which they partly depend on (Ackerman & Stanton 2010). Curiously, over the last several years, SCC estimates have been dropping, even as warming predictions get worse. Since these economic models are highly sensitive to initial conditions, small changes to discount factors have a large effect on estimated carbon costs. While a US federal working group estimated the SCC at $21, some economics assert that under certain plausible assumptions, the SCC can be infinite, due to high uncertainties and extreme risks (Ackerman & Stanton 2011). Even if some lower estimates of the SCC are correct, much of the damage is not actually adaptable. Further, the SCC estimates do not price in a remedy, considering that the SCC will continue to climb over time. And any carbon revenue based on the SCC may disappear into another public good or the private sector and not address climate change at all. Thus, the proposal presented here takes a different approach to pricing carbon. The only way to truly reverse the damages is not emit the carbon in the first place. While this is not possible, carbon removed in one location can compensate for carbon emitted elsewhere, both now and in the future. Thus, the cost of carbon equals the cost of simultaneous removal, but increases with a delay of removal and rising temperatures. A carbon price of simultaneous removal can be approached gradually over time, until an atmospheric equilibrium has been reached. At that point, carbon revenues should be fully utilized to maintain that equilibrium.

2. The risks of cap-and-trade with offsets

Cap-and-trade was first used in the United States to reduce sulfur dioxide released into the atmosphere in order to combat acid rain. For this, cap-and-trade has been somewhat successful. But since sulfur emissions are much smaller than greenhouse gas emissions, are confined to coal-related industries, and are not required for energy production, it has been much easier to achieve a level of equilibrium in the atmosphere. Much was achieved by adding scrubbers to coal-fired plants and switching to coal with lower sulfur content. Greenhouse gas emissions are a very different problem because energy production is a product of burning fossil fuels, not from impurities in the fuels.

However, the Kyoto mechanisms of cap-and-trade and CDM, have largely failed to limit global emissions growth. Kyoto also has not been effective in reducing carbon emissions within the developed and industrialized countries that have ratified it. Recent drops in emissions from some countries during the global recession are only temporary (Friedlingstein 2010). Estimates are that the European Union (EU) Emissions Trading Scheme (ETS) phase II (2008-12) caps will only constrain emissions on covered emitters by a mere 0.3%, with this difference and additional emissions growth allowable by purchasing cheap carbon offset credits from within the EU or elsewhere (Morris & Worthington 2010).

The risks of using cap-and-trade for CO_2 equivalent emissions continue to be substantial and the failure of this approach is not likely to provide time for another chance. Some of these risks have been described earlier by Nordhaus (2009, 2011) and others. In theory, capping emissions and trading the rights to pollute within the cap seems like a plausible approach. With auctions of emissions permits and a secondary market, working capital can be utilized to fund the most efficient ways to reduce carbon emissions in exchange for carbon credits, which can then be sold to industrial polluters where emissions reductions are more expensive. In practice, cap-and-trade becomes very complex as key assumptions are tested and real risks come to light. Cap-and-trade for CO_2 emissions has yet to be validated as effective within the ETS and cannot be truly validated until some time after caps are planned to shrink starting in 2013.

A weak link in a cap-and-trade system with offsets is carbon offset integrity both inside and outside the CDM. The basic assumption is that participants in offset exchanges will act with self-interest, but follow rules which will indirectly aid the global interest. However, human behavior does not typically follow this assumption. While the rule of law affects behavior, law in this domain is currently primitive. Even with laws in place, they must be enforced, but still will not prevent pathways around those laws which are not in the global interest. Offset projects in developing countries may be difficult to verify, because they may not be easily accessible. Carbon offsets are supposed to be eligible for credits if a project would not have been done anyway. However, this is difficult to validate. Suppose a company may or may not cut down their forest for timber. If the company is paid not to cut down a forest, the demand can just shift elsewhere. Money would be paid for offsets, even though there were no real offsets. There is also a significant measurement risk. Gold can be easily weighed, so it makes an excellent commodity. Measuring the amount of carbon sequestered from a forest, landfill or farm is quite a different matter. In the case of the Noel Kempff forest preservation project for creating carbon offsets, estimated CO_2 emissions reductions dropped 90% from original estimates (Densham et al. 2009). Although forest preservation is critical, funding does not need to be based on a carbon market. Proposed forestry offsets in REDD appear to only generate positive credits, despite expected forest fires, disease and even death of some tree species from climate change itself. Investors can seek to grab forestry land for carbon credits with minimal risks, and this can lead to human rights abuses and carbon colonialism (Llanos & Feather 2011). Consider that simple economics sustained slavery for millennia. Have human beings really changed that much?

The CDM has already resulted in multi-billion euro offset frauds, including the case of deliberate overproduction of refrigerant in China, in order to sell destruction of the HFC-23 byproduct for carbon credits (Wara 2007), which for a time was almost 30% of the entire market. Carbon credit carousel fraud in the EU ETS resulted in losses of about 5 billion euros in 2008-2009 and is estimated to account for 90% of the carbon trading volume in some countries (Europol 2009). In January 2011, it was discovered that about 28 million euros in carbon allowances were stolen from several EU ETS national registries, causing trading to halt in all registries. It took two months to bring all registries back online.

In carbon auction markets, blocks of allowances are auctioned for future emissions, so a secondary market is usually necessary for trading excess supply and demand. Auction allowances can be awarded over long fixed time periods, adding additional legal, business and environmental constraints that can take years to unwind. These allowances can lock in business decisions on deploying low-carbon infrastructure and are not adaptable to changing environmental conditions. There is also the possibility that global financial firms could buy emitters to access the auction market, buy up auction rights by outbidding other emitters and then sell emissions securities back to them at a higher cost. In addition, a corruption risk exists when permits and allowances are allocated by politicians to special interests, particularly in their jurisdictions.

Financial corporations and traders act with self interest, sometimes regardless of the consequences. Ceding control of carbon emissions to very large financial firms with an appetite for risk and profits would itself have substantial risks. Some of these firms have manipulated the energy, oil, mortgage and currency markets in the past, at the expense of the common good. Not long ago Enron was heavily manipulating the electricity and energy market to cause price spikes and the world is still reeling from the mortgage crisis. Although these markets are different in some respects to carbon market, manipulation was driven by the same common human behavior which would be active in carbon markets. Similar foreseeable and unforeseeable things can happen with derivatives on offsets, allowances and permits. Some of what is likely to happen is predictable, because it has happened before. Carbon allowances and offsets can be pooled and securitized. This gives financial firms the power to buy the offsets and offset projects they like and directly control the offset market, forcing most companies to buy emissions securities from them. Financial firms would charge transaction and management fees on the pools, buy the cheapest carbon allowances and offsets, and may hide the source, effectiveness and compliance or use a rating firm they hire to assert the carbon instruments are effective. This is similar to what happened in the mortgage market and caused the current global financial crisis. Even in the mature mortgage industry, many home owners cannot find out who owns their mortgage or what mortgage-backed securities pool their mortgage went into. And the financial firms paid ratings agencies to provide high ratings on their sub-prime and other mortgage pools, which ultimately failed. In a new carbon market, this kind of behavior is very likely to occur with carbon instruments. Consider carbon offset origination companies that go into the business of creating domestic and international offsets. Companies selling offsets at a profit would be encouraged to exaggerate their offsets and cut corners to increase profits, forcing other companies to either do the same or go out of business. Offset originators could also create and flip an offset project without considerations of the affected communities, which may lead to inefficient community offset strategies. The risk is huge transfers of capital to financial firms and ineffective carbon reductions. Carbon traders can make profits with arbitrage and momentum trades, which they would be able execute before the intended users of a carbon market could, such as the energy intensive businesses and governments. Linking cap-and-trade markets around the world would enable global high-speed arbitrage trades which carbon trading firms would have privileged access to. Global carbon trading firms would effectively have their own rents on carbon, draining resources which could have been used more directly to reduce carbon emissions.

Secondary carbon markets also have price volatility, adding risk to companies who might need to buy emissions credits. Indeed, companies are exposed to considerably higher market risks, because the price volatility of fossil fuels and carbon allowances are likely to be highly correlated and will sum together. Even if uncorrelated, combined volatility will still increase to the square root of the sum of each price volatility squared. Speculation in carbon instruments do not increase capital for carbon investments, they just increase price volatility, which provides poor price signals for investments in carbon emissions reduction, discouraging investment. Cap-and-trade with offsets can also create perverse effects, such as the movement of manufacturing to poorer countries with low emissions and higher caps, effectively reducing manufacturing costs and then forcing competitors to do the same. However, this would result in increased transport of parts and finished products between manufacturing sites and markets across the world, actually increasing total CO_2 emissions. Global shipping now accounts for about 5% of the total carbon emissions and is already expected to grow substantially.

The global financial system is highly complex, having evolved over much of the 20th century, often during economic crises. Yet, it still needs a lot of work. Cap-and-trade with offsets essentially establishes a whole new monetary system of huge complexity in a short period of time. ETS thus far is still experimental with questionable results. The real risk is that even with a huge effort it still may not work due to complexity, and irreplaceable time will have been lost. Some have argued that the complexity of the climate problem requires a market based approach, therefore carbon trading is necessary. However, there are several markets involved, including for renewable energy, low-emissions products, technologies and services for carbon sequestration. Climate financing can be a based on lending, rather than carbon markets and trading. There is nothing inherently inefficient about a tax based on a stable carbon price of a global commodity common in the atmosphere, particularly with increasing climate change costs for the foreseeable future. In actuality, carbon markets artificially create carbon price inefficiencies, unlike some other commodities. While this is good for traders and governments who collect revenue from traders, it creates negative value on the whole. In addition, due to high complexity, carbon trading adds substantial regulatory risks and high overhead.

3. A harmonized carbon tax

Carbon taxes have been in use since 1990, and are now implemented in Finland, The Netherlands, Norway, Sweden, Denmark, United Kingdom, and the provinces of Quebec and British Columbia in Canada (Sumner et al. 2011). India has a tax on coal. Australia will have a carbon tax 2012-2015. South Africa is currently seriously considering one, as are other countries. Only a couple of countries such have been truly successful reducing local emissions under Kyoto and have done so largely because of a carbon tax, without the need of ETS. For example, Sweden adopted a carbon tax in 1991 and reduced emissions 9% between 1990 and 2006. The current Swedish carbon tax rate in industry is approximately $75 per metric ton of CO_2 (MtCO2), although electricity producers are exempt. The general carbon tax rate outside of industry is $150 MtCO2 and applies to fossil fuels such as petrol. Indications are that emissions would have been 20% higher without this (Global Utmaning 2009). Carbon taxes are often criticized with the claim that they will hurt economic recovery and growth. So, it is worth mentioning that the comparatively high carbon taxes in Sweden do not appear to be negatively affecting economic growth and competitiveness, considering that the Swedish GDP growth rate was 5.5% for 2010 (Statistics Sweden 2011) and Sweden is ranked 2nd globally by The World Economic Forum global competitive index for 2010. In addition, Swedish GDP and fossil fuel consumption are appearing to become decoupled.

Many of the risks of cap-and-trade are substantially reduced or eliminated if a carbon tax is used instead and harmonized across the world. This has been suggested previously in a Swiss proposal during the COP13 Bali Climate Conference (UVEK 2008), Nordhaus (2009, 2011) and by others. The approach detailed here suggests that the global price for carbon emissions per metric ton of $C0_2$ equivalent (MtCO2e) be based on a percentage of the actual cost to remove carbon from the atmosphere. Over time, the harmonized carbon tax can incrementally increase over 40 years until 2050 to reach the true cost of removing the carbon from the atmosphere, adjusting down as the cost of removal drops. By some estimates, the current cost of CO_2 removal by air capture is estimated to be near $360 per metric ton in 2007 dollars, but may not drop below $100 before 2050 (Pielke 2009). If the cost of CO_2 removal is initially estimated to be $300 in 2050, then a harmonized carbon tax can incrementally increase by $8 each year, starting at $8 in 2013. This tax would start low, but provide predictability and incentives for industries and other emitters to become more carbon efficient.

The tax would be assessed on whatever party intends to emit the CO_2, and collected in the international, national or local jurisdiction where it will be emitted. For example, when coal is burned for electricity, the utilities would pay the tax on carbon emissions. For oil products, emissions taxes from extraction and refinement would be paid by the producers, but the taxes on CO_2 released from burning the fuel would be paid by consumers, such as with an added petrol tax. If the taxes are assessed too far upstream outside the jurisdiction of emissions, then the collected revenues cannot be applied to reduce those emissions. Methane emissions in non-farm sectors could also be taxed at higher levels than CO_2, since it causes 21 times more heat retention. This would encourage collecting and burning Methane to produce energy whenever possible, even though a byproduct is CO_2. Countries would collect carbon taxes internally and invest those funds internally in reducing emissions, climate change adaptation, low-carbon infrastructure, protecting natural carbon absorbers, climate research and MRV. This would create economic growth and fuel the right kind of carbon market, one for creating and implementing solutions. Companies might also deduct direct investments in carbon emissions reduction from the carbon tax. A harmonized carbon tax would be much easier to implement and adds badly needed elements of certainty and predictability. It is also more adaptable to changing environmental conditions, unlike national cap-and-trade plans with fixed targets. Further, Carbon taxes do not require a secondary market since taxes can be paid based on actual emissions.

4. The Green Climate Fund

The GCF as authorized in Cancun is close to formation, based on the preliminary Report of the Transitional Committee for the design of the Green Climate Fund (UNFCCC 2011). However, the critical mechanisms of funding and disbursement have yet to be determined. Several funding mechanisms have been proposed by the High-Level Advisory Group on Climate Change Financing, including carbon markets, carbon taxes, international transport fees, financial transaction taxes and direct budget contributions (AGF 2010). While a consensus was not achieved, it was emphasized that a carbon price was an important component. The GCF is targeted to grow to $100 billion by 2020, but there is debate on what the ratios of public and private funding should be. Private finance in the developing world has been quite limited in the past, concentrating primarily on a small set of emerging nations (Atteridge 2011). In addition, $100 billion is considered by many to be too low.

This paper explores a specific implementation, which favors harmonized carbon taxes over carbon markets and applies the harmonized carbon tax rate to international transport. Private finance is profit seeking and cannot be the primary driver for shifting to more expensive sustainable development, so it is assumed that $100 billion will be public funds, further leveraged by private investment. Among the other mechanisms, financial transaction taxes are not a good source of funding for climate finance because financial activity is weakly coupled with CO2 emissions and over the long term should actually become decoupled. This makes it an unreliable funding source with unnecessary dependencies and unforeseen consequences, which would add risk on a global level. Better to limit any financial transaction taxes to the domains of banking and financial markets, which are also unstable and need improved regulations. A financial transaction tax also does not contribute an incentive to reduce emissions. Direct budget contributions are problematic because of very high sovereign debt levels in developed countries, and these contributions cannot be scaled to the levels necessary for climate finance.

Funding the GCF becomes straightforward in the context of a harmonized carbon price framework. Developed and industrialized countries have emitted much more CO_2 over time and have some historical responsibility. To compensate for this, each country can contribute a percentage of internally collected carbon taxes into the GCF, based on national wealth and the total amount of CO_2 emissions from fossil fuel consumption within a sliding window of 62 years (2 CO_2 half-lives) or since 1950. The contribution percentages can be scaled up or down, depending on the needs of the GCF. The harmonized carbon tax can also be applied to international shipping, with the entire proceeds going into the GCF. If a country is not party to the framework, a tariff equivalent to the carbon tax could be assessed on imported goods and services into compliant countries, with the entire proceeds going into the GCF. A country is encouraged to participate in the framework because that country can instead invest carbon tax revenue internally on carbon emissions reduction projects. The GCF would aid developing nations in climate adaptation and mitigation such as development of cleaner infrastructures, protecting carbon absorbers such as the rain forests and aid for family planning, which has been shown to be highly cost-effective in the developing world (Bongaarts & Sinding 2011). Some funding is also needed on a global level in related areas, such as global climate monitoring, analysis and compliance. Global R&D funding can accelerate development of renewable energy and promising technologies such as Thorium nuclear reactors, which have a lower proliferation risk, are safer to operate and have less radioactive waste (IAEA 2005), while also consuming existing radioactive waste. Funds can also be used obtain patent rights from private companies for transferring low-carbon technologies to developing countries.

More formally, funding for the GCF can be based on a harmonized carbon tax T on MtCO2e emissions, current carbon emissions E_n of each nation, cumulative historical carbon emissions since 1950 nationally H_n and globally H_g national wealth W_n and a contribution rate G_r into the GCF of nationally collected carbon taxes. Equations will be presented using these values.

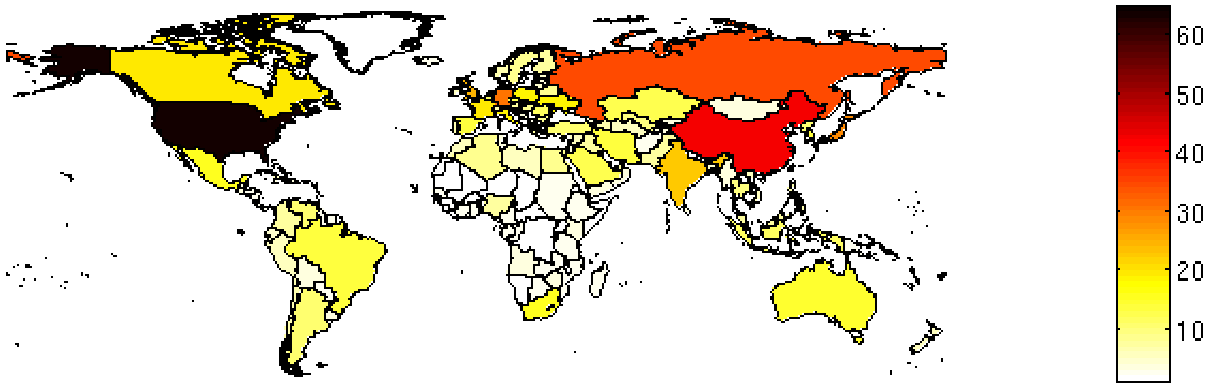

Figure 1. Historical emissions from burning fossil fuels 1950-2007 in billions of metric tons of carbon. Source data from T.A. Boden, G. Marland and R.J. Andres at CDIAC, Oak Ridge National Laboratory, 2009. Modifications were make to extend emissions in some countries backwards to 1950 by combining retroactively in cases such as the former East/West Germany or by using post-breakup ratios in cases such as the former Soviet Union countries.

Based on the cumulative emissions as seen in figure 1, national historical responsibility, R_n, can be represented as a ratio of national historical emissions H_n to global historical emissions H_g.,

$$R_n \triangleq \frac{H_n}{H_g} \qquad (1)$$

For determining national wealth, consider the following:

$$g_n \stackrel{\text{def}}{=} national\ GDP\ per\ capita$$
$$\sigma_g \stackrel{\text{def}}{=} standard\ deviation\ of\ the\ national\ GDP\ per\ capita\ across\ all\ nations$$

National wealth W_n is determined by subtracting the global mean of GDP per capita and an offset Z from the national GDP per capita g_n and dividing this by the standard deviation of the GDP per capita across all countries σ_g. Countries that have a GDP per capita below the global mean have a negative wealth factor, when the offset adjustment Z is zero. A positive Z pushes the zero cutoff towards richer nations and a negative Z pushes it towards poorer nations.

$$W_n = \frac{g_n - \langle g_n \rangle - z}{\sigma_g} \qquad (2)$$

If W_n for a nation is above zero, the country is considered rich enough to contribute to the GCF. In figure 2, this would be countries above the threshold, where $W_n = 0$ and Z = 0 in this example.

Calculations for national wealth could be expanded to include sovereign debt and foreign currency reserves, with appropriate discount factors.

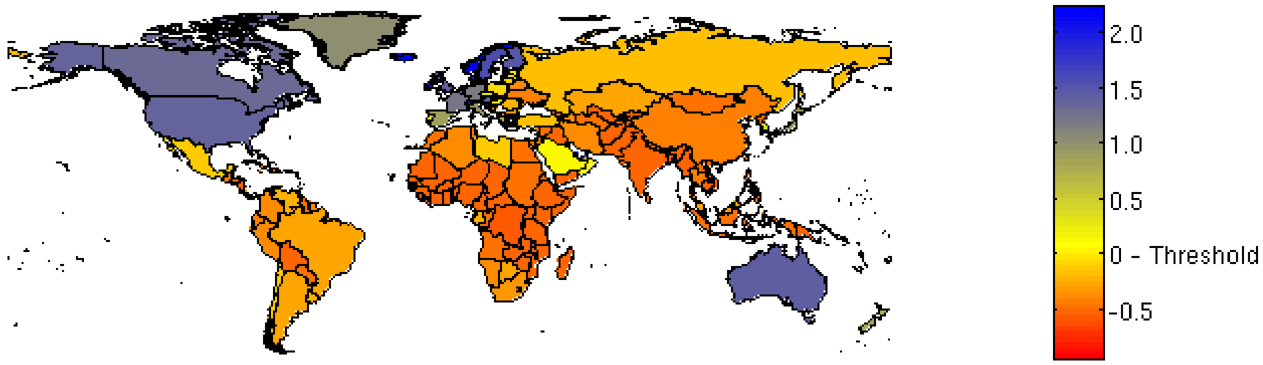

Figure 2. Wealth W_n of all nations in 2007 with potential fund contributors above the threshold. Calculations are based on equation 2 with $Z = 0$.

Given national emissions E_n of greenhouse gases, a carbon tax rate T, a global contribution rate G_r, and the total contribution F^{in} into the GCF for a total of N countries,

$$F^{in} = G_r T \sum_{n=1}^{N} R_n W_n E_n \quad when \;\; W_n \geq 0 \qquad (3)$$

The global contribution rate G_r can be calculated to start initial funding for climate aid at $10 billion in 2013. After this, funding will increase as the carbon tax T increases. As an alternative, historical responsibility and national wealth alone can be used to determine the percentage of contribution C_n from each nation into the GCF. In this case, funding does not scale up with an increasing carbon tax and would likely be insufficient over the long term. In (4), V equals the sum across all nations of the product of factors for historical responsibility and wealth. V is used in (5) for normalization to obtain a contribution percentage C_n for each nation. Equation (6) sums all contributions into the GCF. This approach requires agreeing on the GCF size explicitly from the top down and will not take into account national emissions growth except that higher cumulative growth will increase historical responsibility. However, the effects of increasing emissions or potential emissions reductions failures could be compensated for somewhat by additionally multiplying E_n in (6) with a ratio of the current national emissions with respect to 1990 levels.

$$V = \sum_{n=1}^{N} R_n W_n \quad when \;\; W_n \geq 0 \qquad (4)$$

$$C_n = \frac{1}{V} R_n W_n \quad when \;\; W_n \geq 0 \qquad (5)$$

$$F^{in} = G_r \sum_{n=1}^{N} C_n E_n \qquad (6)$$

All revenue from the harmonized carbon tax entering into the GCF can be disbursed as F^{out} in (7) to fund several global climate initiatives as well as climate aid, where:

$F_g^{ca} \stackrel{\text{def}}{=} total\ global\ climate\ aid$
$F^{rd} \stackrel{\text{def}}{=} climate\ R\&D\ and\ technology\ transfer\ at\ the\ global\ level$
$F^{cm} \stackrel{\text{def}}{=} global\ climate\ monitoring$
$F^{gc} \stackrel{\text{def}}{=} global\ emissions\ compliance$

$$F^{out} = F_g^{ca} + F^{rd} + F^{gm} + F^{gc} \qquad (7)$$

The total disbursement of climate aid F_n^{ca} to each nation is based on the following need factors:

$A_n \stackrel{\text{def}}{=} relative\ adaptation\ needs, for\ each\ nation$
$S_n \stackrel{\text{def}}{=} relative\ needs\ for\ preserving\ carbon\ sinks\ (such\ as\ rain\ forests), for\ each\ nation$
$M_n \stackrel{\text{def}}{=} relative\ needs\ for\ mitigation\ and\ low\ carbon\ infrastructure, for\ each\ nation$
$L_n \stackrel{\text{def}}{=} relative\ needs\ for\ lowering\ population\ growth, for\ each\ nation$

National climate need factors A_n, S_n, M_n, L_n can be defined as within a range from zero to a maximum such as 0-100. Additional need factors can be easily added to this formula. Needs for lowering population growth and family planning are included because this is a key driver of emissions growth. Inputs such as the Environmental Vulnerability Index can be very useful, but ultimately funding is likely to be a political decision. One alternative is that each country can rate the need factors of all other participating countries. However, there is a risk countries could assign maximum needs to themselves and their allies, but to no other countries. In another alternative, each country can be given a fixed allocation of credits, 10,000 for example, and asked to assign them across all countries. All assignments can then be averaged for each need factor to compute A_n, S_n, M_n, L_n for each nation. Assignments might also be weighted by a number of factors, such as compliance. This method can provide a transparent and democratic method to solve the distributive justice problem of fairly allocating the limited resources of the GCF.

In (8), the relative need factors are summed for each nation and divided by the maximum need factors to determine the total relative need. This is multiplied by the national population P_n in 2010 to scale national needs appropriately and then divided by national wealth $W_n + 1$. W_n is always greater than -1, so the denominator is always positive, approaching 1 when W_n is negative and approaching 0. The poorer the nation is, the more the total needs are increased. The total population size is fixed at 2010 levels to not encourage population growth, by effectively reducing funding per capita if populations are not stabilized and continue to grow. The relative importance of the need factors can be changed by placing a coefficient in front of the need factors. All the total need factors across all nations will be summed by (8) and used for normalization in (9). Equation (10) asserts that all climate aid funding to nations should add up to the total global climate aid.

$$U = \sum_{n=1}^{N} \frac{A_n + S_n + M_n + L_n}{A_{\max} + S_{\max} + M_{\max} + L_{\max}} \frac{P_n^{2010}}{(W_n + 1)} \qquad (8)$$

$$F_n^{ca} = \frac{F_g^{ca}}{U} \frac{A_n + S_n + M_n + L_n}{A_{\max} + S_{\max} + M_{\max} + L_{\max}} \frac{P_n^{2010}}{(W_n + 1)} \qquad (9)$$

$$F_g^{ca} = \sum_{n=1}^{N} F_n^{ca} \qquad (10)$$

These equations are used with published data to give an example of how the funding can work. The climate funding graphs in figure 3 use financing equations (1,2,3,8,9 & 10) and available historical data as an example for collecting revenue for the GCF and dispersing funding aid. Historical responsibility R_n was based on fossil fuel emissions between 1950-2008 (Boden 2009), with some modifications. Emissions were combined retroactively in some countries such as east/west Germany. Emissions were split retroactively between other countries, such as the former Soviet Union, by using post breakup ratios. Prior to 1950, the data are incomplete, but 1950 onwards provides a good estimate for historical responsibility, considering the world did not acknowledge the climate problem until the United Nations conference in Rio de Janeiro in 1992. Between 1900-1950, emissions rose 16 ppm. Using a CO_2 atmospheric half-life of 31 years, the current contribution of those years is approximately 4 ppm, less than 2 years at current emissions levels. Emissions data due to deforestation and land use changes are incomplete, so they were excluded. For GCF contribution calculations, deforestation is less important, because much of the deforestation occurred in countries of low wealth, and so they would not be contributing to the GCF anyway.

To calculate national wealth W_n in (2), GDP per capita data for 2008 was used (UNdata 2011) and the offset Z was set to zero. With historical responsibility R_n, and (5), contribution percentages C_n were calculated for each nation, as shown in Figure 3A. To calculate the total contributions F^{in} into the GCF, (3) was used. In (3), national emissions E_n used 2008 data for greenhouse gas emissions without land use, land use change and forestry of the 40 UNFCCC Annex I countries (UNdata 2010). The global contribution rate G_r was set to 0.66 to achieve a total of \$12.5 billion in funding for 2013, increasing each year by \$12.5 billion to reach \$100 billion annually in 2020. In the event that revenue also comes from a carbon tax on international shipping, the global contribution rate can just be lowered to produce the same funding levels. To calculate these future revenues, greenhouse gas emissions are fixed in contributing countries at 2008 levels during 2013-2020. Funding contributions only came from the 40 Annex 1 countries with a positive W_n, or the 23 Annex II countries plus the Czech Republic, Estonia and Slovenia. 58 countries actually had a positive W_n, but those excluded were mostly small (except Greenland, Israel, Kuwait, Oman, Republic of Korea, Saudi Arabia, United Arab Emirates) and equivalent greenhouse gas emission data was not available. As an example of how this would work, the United States (US) would contribute 50.4% of the GCF, based on historical fossil fuel emissions and national wealth. If the carbon tax is \$8 per MtCO2e for 2013, the US would contribute 20.6% of that or \$1.65 per MtCO2e towards the GCF. If the carbon tax increases \$8 each year, it will be \$64 per tCO2 in 2020, and the US would still contribute 20.6% or \$13.2 per MtCO2e towards the GCF. The remainder would be used internally in the US for addressing climate change, including mitigation and adaptation.

To show an example of how disbursement of climate aid can work, it is assumed all nations with a wealth factor W_n of less than zero (2) have equal need factors, except for China and India, which have been set to zero, since both countries declared they would not seek climate aid. The need factors for the nations of Europe are intentionally not reduced to show distribution effects. In reality, all need factors would vary across countries. For example, the Small Island States and parts of Africa would likely have high need factors for adaptation.

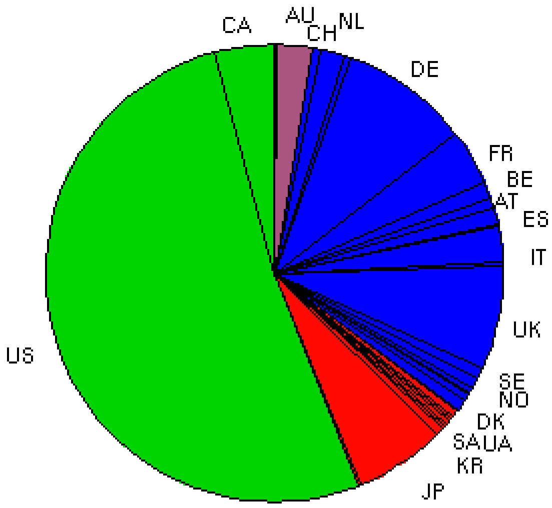

Figure 3A. National contributions into the GCF based on historical responsibility and national wealth.

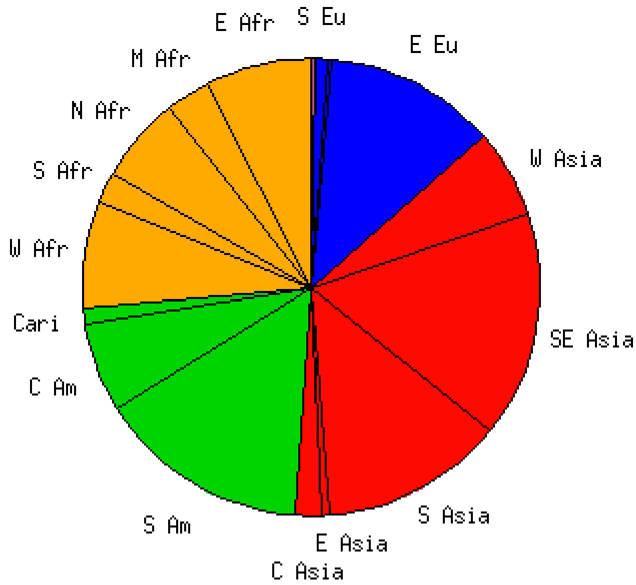

Figure 3B. Distribution of aid from the GCF into regions based on national need factors.

On the funding side in figure 3A, the United States (US in green) comes out as the largest contributor at 50.4%. Europe (in blue) is the second largest contributor at 33.1%, Japan (JP in red) third at 7%, Canada (CA in green) fourth at 4.1% and Australia (AU in purple) follows at 1.3%. The US is the largest contributor because it has a per capita GDP of $45k, the 2nd highest emissions per capita and the highest historical responsibility for CO_2 emissions. Figure 3B shows climate aid distribution. With the set need factors, Asia (in red) would receive most of the funding, followed by Africa (in orange), Americas (in green) and Eastern & Southern Europe (in blue). Several countries in Eastern Europe and a couple of them in the EU (such as Romania, Hungary, Poland) have a negative W_n.

5. Discussion

This GCF collection and distribution strategy can be adjusted with a few parameters, which include the harmonized carbon price, global contribution factor, a wealth factor cutoff adjustment and need factors for all countries who receive climate aid. This strategy can be applied at the global or regional level, such as within the EU or across the states of the US. For example, Poland is less wealthy than many nations in the EU and relies heavily on coal. By applying these formulas at the EU level, aid from more wealthy nations can help Poland either move away from coal or deploy carbon sequestration technologies. In the US, states such as Wyoming, Montana, Pennsylvania, Ohio and West Virginia are heavily dependent on coal. As such, they often seek to block national climate legislation that disadvantages them. However, with the right approach, states which are dependent on coal can be aided by other states less dependent to reduce emissions and thus make legislation more likely. GCF contributors and beneficiaries can be made to overlap by adding a small constant to W_n in equation (3), which lowers the wealth contribution threshold. While a carbon tax of $64 MtCO2e by 2020 is higher than many suggest, the revenue can be reinvested in climate mitigation and adaptation at the national level, such as building more efficient transportation systems, power plants or energy grids. These necessary improvements will require additional public funds, which are typically not accounted for in other approaches. Carbon taxes can be regressive by taking a larger percentage of income from lower income households (Ackerman 2008). Some proposed legislation in the US has included a cap and dividend approach, where some carbon revenue is returned on a household or per-capita basis, effectively providing a carbon allowance. This can be done with harmonized carbon taxes as well, as long as the harmonized carbon tax rate is sustained. For example, a fuel tax could be above the harmonized carbon price with the difference returned to lower-income households to remove regressive properties. In this case, the harmonized carbon price within a country would be a mean carbon price. In least developed countries where poverty is high and carbon emissions are low, a national carbon allowance could be allowed, free of carbon prices. However, this allowance should perhaps be based on land mass rather than population size to avoid encouraging population growth. Consider that climate change is a planet-centric ecological and environmental problem caused by humans, not a human-centric one.

With a harmonized carbon price, behavioral changes are encouraged from the bottom up, while not relying on setting national or per capita emissions targets. Some have argued that a small carbon tax does not alter behavior. However, a fixed small tax is substantially different than one which starts small but steadily increases over time, evoking continued consumer attention to act on consumption. Completely relying on a collection of national targets is very risky, because they are very hard to adapt with changing environmental conditions that are truly global in nature. Harmonized carbon price increments can be accelerated if global emissions targets are not being met. The fact is, new revenue is needed to address climate change, so it is not enough to replace some existing taxes with carbon taxes. It would also be best in the long run if carbon revenue is focused exclusively on climate change rather than mixing it with other revenues. Carbon revenue can be reinvested in climate change needs in the near to mid term, but eventually used to finance removal of newly emitted carbon from the atmosphere for achieving a carbon equilibrium. This is the fastest way to transition to low-carbon economies and this will create economic growth.

Private capital can be leveraged with these funds, but under the administration of a local authority, who can choose mitigation projects strategically for optimal effectiveness while minimizing negative impacts on local communities. Governments might manage mitigation projects with bids and audits, just as transportation and highway systems are now. Mitigation projects can be peer reviewed, helping to identify best practices by governments. This method is more likely to develop efficient projects instead of what investors might pass off as an offset project and sell to financial firms for pooling and securitization. The money to fund mitigation projects still comes from emitters through carbon taxes, and the pool of capital would probably be higher than with a cap-and-trade system such as ETS with CDM, because less is lost to carbon trading, speculation and fraud. While a harmonized carbon tax can eliminate the need for carbon markets, a huge potential would still exist for private industry to create low-emissions products and services, while also building and maintaining low-carbon infrastructure. Mitigation funding and carbon tax revenue can leverage private capital by helping to cover higher near-term cost differences in building low-carbon infrastructure and energy-production. Public and private loans can also provide additional capital with stability, payable with incrementally increasing carbon tax revenues.

6. The current political climate

Copenhagen and Cancun appear to have failed to produce a comprehensive treaty because of the sheer complexity of trying to get 192 nations to agree on what action to take on climate change. While input from all nations is important, a better structure is needed. It is not enough to limit discussions to major polluters such as the G20, because those affected the most, such as the Alliance of Small Island States (AOSIS) and African nations, would not be represented. A better solution would be to have a hierarchy for discussion, analysis and decision making. Each nation could be directly represented at the bottom of the hierarchy. The next level could be represented by groups of nations with common qualities. Nations are free to move between groups if another one is more representative. A further level might contain groups of groups. At the top level, treaty negotiations would occur. Large nations such as the US, China, India or the EU may have direct representation at the top level. Ideas and concerns could be introduced by any nation for discussion within a group. If one third of the nations in a group agree on ideas and suggestions, they can propagate up the hierarchy. At the top level, a policy proposal is created with these suggestions in mind. This proposal is propagated down the hierarchy for feedback. Updating and feedback iterations can continue until at least 2/3rds of the nations in each top group agree. If deadlock exists at the top level, a majority of the top-level groups or large nations may choose to break off from the others and form a separate agreement. For example, the US, China or OPEC nations should not be able to block an agreement if others have achieved a consensus.

At Copenhagen, there was discussion about fairly sharing atmospheric space, or the right to emit carbon. Least developed countries including Africa fear of being locked out of access to atmospheric space, locking them into perpetual poverty. If the world has an emissions cap to stay below 2° C, and developed nations reduce emissions to 50% of 1990 levels by 2050, then there is little room left for poorer nations to emit for economic development. However, there is another way to look at this. Consider that there is no longer any free atmospheric space left, because atmospheric CO_2 levels are already too high. All carbon emissions have an environmental cost across the globe. Part of the revenues from carbon pricing in nations with historical responsibility can be used to cover the additional expense in underdeveloped countries of low-carbon development over utilizing fossil fuels. Those additional expenses may be higher initially, but will drop as deployment increases. Thus, development is not constrained, but shifted towards sustainability. Initially developing with fossil fuels and shifting later to low-carbon infrastructure is not only environmentally unsustainable, but more expensive in the long run.

China's economic growth is aided by cheap labor, relatively weak regulations as compared to developed nations, cheap energy from coal and an undervalued currency. While economic growth is essential to reduce China's poverty, this growth appears to be valued above all, despite the fact that climate change will actually increase poverty. Resistance to revaluing its currency may indicate a similar resistance to reduce emissions, already the highest in the world. China is actively pursing development of clean and renewable energy and according to the Pew Environment Group, invested $54.4 billion in 2010, more than any other country. They are also developing nuclear energy, including Thorium reactors. But, China produces and burns more coal than any other country, obtaining 71% of its energy from this. Further, Chinese coal consumption is expected to increase about 150% by 2035 (EIA 2010). Even if China meets its stated goal of reducing carbon intensity by 40-45% of 2005 levels by 2020, its emissions will continue to grow. Assuming a carbon intensity reduction of 45% and an average GDP growth rate of 8% between 2005 and 2020, emissions growth would be 74% above 2005 levels in 2020. This largely wipes out reductions by other parties. Although China correctly asserts that developed nations have historical responsibility for carbon emissions, China itself has substantial historical responsibility as well. From 1950-2007 it contributed 11.2% of the global carbon emissions from fossil fuels and was burning coal as far back as the Han Dynasty, about 206 BC – 220 AD. China is already experiencing serious air pollution from burning coal and the effects of climate change. This includes the rapid disappearance of grasslands on the Tibetan plateau along with desertification and water scarcity. China has an ambition of becoming a dominant superpower and is in a competitive struggle with the US. Despite claims of an open market, it is reluctant to buy foreign goods and instead wants indigenous companies to dominate in most industries, including green technology. With its massive foreign currency reserves, it could increase imports of available technologies to more quickly build a lower carbon infrastructure or purchase fuels with lower CO_2 emissions. The US has lost industry to China and won't be willing to reduce emissions substantially unless China does as well because otherwise China would have even more of a competitive advantage. Unfortunately, this competitive struggle has the potential to derail or sufficiently delay any effective climate response for preventing catastrophe. In fact, it has already contributed significantly to climate change, because it was the main reason the US stayed out of the Kyoto protocol. This conflict is becoming another Mutually Assured Destruction on an environmental level, but unlike a nuclear standoff where there is some probability of disaster with a triggering action, this one is likely to occur with inaction. China could help itself and the world by imposing a carbon tax quickly and use all the revenue to reduce carbon emissions.

Historically, the US is the largest contributor of carbon emissions into the atmosphere, yet at the national level, it is doing the least among industrialized countries to limit or reduce those emissions. The US Environmental Protection Agency (EPA) was planning to start regulation of CO_2 emissions in early 2011, but this has been delayed. While the US increased fuel economy standards to 35.5 mpg for 2016, China is already at that level. The US seems to favor relying on the Cancun pledges and delaying a new treaty until after 2020. But this would likely condemn the most vulnerable nations to severe damage or worse. This may be because the Cancun pledges are bilateral, allowing the US to exert more political influence in exchange for climate aid than would be possible within a new global treaty. Another reason for stalling might be to reduce historical responsibility, at least relative to the emerging countries. Internally, the US Republican party does not appear willing to address climate change. Republicans appear to be hiding behind a façade of climate denial, claiming to be skeptical even while blocking climate research funds and trying to defund the EPA. Perhaps they are disproportionally representing special interests, while also exploiting fear, uncertainty and doubt in the general US population. With strong Republican opposition to addressing climate change, US legislation is not likely to pass before 2013. This is unfortunate, because in recent history, US economic growth has been largely due to the development of new technologies. Without a price on carbon, the US has a weak internal market for new greener technologies and will likely miss opportunities to develop them, negatively affecting both US competitiveness and the US economy. True economic growth needs drivers. Ultimately, the failure to act exposes the US to willful negligence and damages resulting from global warming, potentially causing major international conflicts which would be more damaging politically and environmentally and even more expensive over the long term. California and Texas are already feeling the effects of climate change, with dryer climates and more serious forest fires. If droughts become common in the southwest and spread east to the farm belt, it will be too late to avoid serious consequences of climate change. Because the US generates considerably more carbon emissions per-capita than almost all developed countries, it is likely more sensitive to carbon pricing, and larger business and lifestyle changes will be necessary than in Europe, for example. There also seems to be an internal view that the US is somehow entitled to have very high emissions, with impunity. It may require considerable external pressure on the US to achieve the political acceptance necessary to seriously address climate change.

In the US state level, California passed the Global Warming Solutions Act (AB 32) in 2006 to direct the California Air Resources Board (ARB) to determine the best way to reduce emissions. But ARB was biased from the beginning to use cap-and-trade and was subsequently ordered by a court to do an analysis of alternatives. The resulting AB32 Scoping Plan Supplement (ARB 2011a) was still highly biased, and despite rather obvious disadvantages when comparing cap-and-trade with carbon taxes/fees, none were listed (AB32 Scoping Plan Supplement; page 112; Table 2.8-1). So, it appears a political decision was made outside the scope of AB 32 to adopt cap-and-trade. In October 2011, the ARB finalized the cap-and-trade rules (ARB 2011b). In the regulations, it appears that free allowances to corporations have no transparency. While formulas are specified to calculate allowances, there is no indication that any underlying data or allowance allocations will be made public. So, who is to prevent corruption, and the trading of political favors for allowances? With the high overhead and risks of cap-and-trade, it appears that politicians somehow believe there will be some economic benefit to becoming a carbon trading center. But if California cannot even do a convincing economic analysis for itself, it is hard to see why potential regional partners should buy into their scheme.

India is aligned with China's position within the BASIC coalition, perhaps to prevent limiting economic growth. However, India has a high risk of impacts from climate change. By the 2030s, temperatures are projected to rise about 1.7 – 2.0° C and temperature extremes will have considerably higher variance than they have today (INCCA 2010). Some southern, coastal and central areas of the country are expected to receive less rainfall and have higher evapotranspiration rates, increasing the likelihood of water scarcity and reduced crop yields. Northern areas near the Himalayas are expected to experience increased precipitation, and risks of major flooding will increase as well, not only in India but also neighboring Bangladesh and Pakistan. Flooding in the Ganges river delta could be devastating. In addition, population growth will contribute to continued poverty and is also not environmentally sustainable. India has a goal of reducing carbon intensity 24% by 2020 from 2005 levels, but this too means substantially increased emissions. Already, India is the 3^{rd} largest emitter at 5% of global emissions after China at 23% and the US at 22%. However, India is actively engaged in transparently measuring and reporting emissions. Additionally, in July 2010, India introduced a carbon tax on coal to fund clean energy research projects and is pursuing nuclear energy, including research on Thorium reactors. While India has recently retreated back into intractable solution space, it could still play a pivotal role. For instance, it could offer to raise its coal tax if the US, China and South Africa will impose the same price, provided that all revenues are used to address climate change and that the US contributes some revenue to finance the GCF.

The EU appears to be motivated to significantly reduce emissions and to help establish a new global climate treaty. Unfortunately, because it was first to establish a carbon-based cap-and-trade system with ETS, it now has a vested interest in such a system. As such, it is less likely to look objectively at the failings of ETS and may try to perpetually fix it rather than to consider dropping it in favor of a harmonized carbon tax. Although ETS and carbon taxes can and do coexist, this is overly complicated on a larger scale, creating market uncertainties and high regulatory overhead. One possibility is to set the carbon floor price within ETS to a harmonized carbon price and not allow any carbon offsets to be applied below that price. Or, perhaps different sectors could utilize only carbon taxes or carbon markets, but this would have to be consistent globally. The EU is considering carbon tariffs on nations without a cap-and-trade system, starting in January 2012 with required ETS emissions permits on commercial airline flights. But depending on how they are implemented, carbon tariffs imposed at trade borders have the potential of starting a trade war. They may also be challenged in the World Trade Organization (WTO) (Hufbauer and Kim, 2009). If import tariffs are imposed to protect industries under a carbon tax or cap-and-trade system and revenue is transferred into EU or national government coffers, this could be considered protectionist. However, if tariffs are only assessed on differences between carbon prices between the importing and exporting countries and the all proceeds are transferred to the GCF, there is no national protectionism. This would likely be compatible with WTO General Agreement on Tariffs and Trade (GATT) article III.

Some corporations seek to prevent a carbon price, wherever it might appear globally. They threaten to move their industries or reduce employment, claiming a loss of competitiveness. If they can't kill it, they seek huge concessions. Few suggest a harmonized carbon price to level the playing field. The corporate calculus is typically to maximize return for investors, with little regard for the environment, and is one of the main reasons why creating a new treaty has been so difficult.
For example, consider ArcelorMittal steel, the largest steel company in the world. After claiming they would have to leave Europe if subjected to carbon pricing, the EU gave them many free carbon allowances. So many in fact, that they earned 211 million euros in 2008-2010, without the need to reduce emissions. Additional future allowances may provide much higher windfall profits while the company actually increases emissions (Morris & Worthington 2010b). More recently, ArcelorMittal insists that proposed carbon taxes in South Africa will kill the South African steel industry. No word from them on harmonizing carbon prices to remove competitive pressures. In addition, corporations can shop around in countries and carbon markets for free carbon trading allowances, and they will likely get them. It becomes a new competitive game, where in the end, emissions are not reduced.

7. Possibilities for a new climate treaty

So what is a possible approach for a new treaty to reduce global carbon emissions? Keep some existing principals in the Kyoto protocol such as the common but differentiated responsibilities of nations, but change the implementation of burden sharing rules and its mechanisms. Phase out all carbon credits within Kyoto by the end of 2012. A fast failure is better rather than one with a likely outcome of insufficient emissions reductions. Ignore the extensive lobbying of the financial industry, which is motivated by self-interest and not the global interest. Establish a new treaty, where all participating nations agree to a globally harmonized carbon price and common environmental regulations. Have nations with historical responsibility contribute a percentage of internally collected carbon tax revenues to the GCF, as described earlier. In return, limit climate change liabilities from historical emissions. Have a global climate committee meet quarterly to adjust the global levers, which are the harmonized carbon price, the global contribution rate, GCF priorities and need factor adjustments for each nation. Annually, let treaty nations decide the need factors of their peers. Base climate related project funding on national need factors to fairly distribute funding across all countries. To receive financing from the GCF, a nation should be part of the treaty. Finance the existing Adaptation Fund directly from the GCF instead of a 2% levy on the carbon market. Treaty nations with climate-related projects should contribute part of the financing with locally collected carbon taxes to give them a sense of ownership. Technology developed with R&D funding from the GCF should be shared with all treaty participants. A harmonized carbon tax should be assessed on emissions from international shipping and transport between treaty participants and any non-participants, with the entire proceeds going into the GCF. But there must be a cost for free-loaders. Nations which do not wish to participate in the treaty should be assessed a tariff on carbon emissions from goods and services imported into participating nations, equal to the harmonized carbon price. All tariff proceeds should also go into the GCF. If a nation decides to assess their own import tariffs in retaliation, this would still be a superior outcome than avoiding a tariff and perpetuating climate change. In this case, re-localization of manufacturing to treaty nations seeking higher energy efficiency has the benefit of reducing global carbon emissions.

The longer action is delayed, the harder a solution will become, both environmentally and economically. Accelerating climate change will later require steeper emissions cuts, even as adaptation costs rise. The fastest and ultimately cheapest way to respond to climate change is to briskly drop cap-and-trade, establish a globally harmonized tax and use all proceeds to directly address the problem. The challenge comes down to this: Has human civilization advanced enough to look beyond national, corporate and individual self interests to not irreparably destroy the global environment that sustains it? Thus far, this has not been demonstrated, but with time running short, the defining answer is not far away.

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