CLIMATE SYSTEM

Exploring Trade-Offs in Climate Change Responses

XMNR 2020 Assignment 4.4 Dr. Bruce Hull

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"Only with the moment of time represented by the present century has one species-man-acquired significant power to alter the nature of his world."

~Rachel Carson from Silent Spring (1962)

Climate Change – The Great "Threat Multiplier"

"[S]tressors…such as poverty, environmental degradation, political instability, and social tensions…" (Bryan, 2017) are bubbling at the surface as we tempt nature with rising levels of greenhouse gas emissions. Staying within the global CO_2 budget between now and 2100 CE to limit warming to 2°C is delusional if politics and the interests of the elite are continually given priority over the commons. As Klein says, "…the only thing rising faster than our emissions is the output of words pledging to lower them." This circular conundrum between growing the economy and saving the environment has paralyzed large scale mitigation momentum (with one conceivable exception). It has us banking on economic growth and innovation to help us adapt to the climate variability we have induced. But what about those unable to safeguard themselves from a future they had no part in creating? What justice do they deserve for their inheritance and the sacrifice of catching up in the same way developed countries flourished?

Climate system strategies come with profound trade-offs, heavily prejudiced by politics. Middle ground is likely found in the space of 'and' – where realities must co-exist. Mitigation *and* adaptation. Economic growth *and* protecting the environment. Equity *and* justice.

Climate Justice (Megan Fink)

Climate Justice considers the needs of today's most vulnerable communities while ensuring "the burdens and benefits of climate change and its impacts" are shared equitably (MRFCJ, 2020). It requires that wealthy, developed nations, who have been the primary contributors to greenhouse gas emissions, pay their fair share toward mitigation and adaptation strategies. Especially considering that "for most poor countries there is >90% likelihood that per capita GDP is lower today than if global warming had not occurred" (Diffenbaugh & Burke, 2019). If we are to reach net zero carbon emissions, globally, by the end of the century, rapidly developing countries must blaze a new path, very different from the fossil fueled one of today's developed nations. The Green Climate Fund set up a Private Sector Facility to help developing nations forge this sustainable pathway and absorb the risks of "low-carbon and climate-resilient development" (GCF, n.d.).

Jairam Ramesh, India's former minister of the environment, states that, "India must view the era of the green economy not as a threat to its developmental plans . . . [but] as an opportunity to build and demonstrate technological capability to the world" (Porter, 2015). Emissions reduction policies can support developing nations during this transition "— for instance by using revenue from carbon taxes to pay for social insurance" (Porter, 2015). However, we cannot discount the nationalistic movement spreading across the world today and what that might mean for international cooperation. Climate Justice holds all nations accountable and prioritizes intragenerational equity to achieve SDGs.

Mitigation with Energy Conservation (Karen Zhang)

According to the United Nations, energy is the dominant contributor to climate change, accounting for around 60 percent of total global greenhouse gas emissions (SDG 7, n.d.). Economic growth is the primary driver of energy demand and related carbon dioxide (CO_2) emissions. The abrupt halt of economic activities because of COVID-19 has created a temporary reduction in carbon emissions and demonstrated the possibilities for limiting these emissions permanently with heavy costs. Mitigation efforts focused solely on CO_2 will not be enough to reverse or even slow climate change in the next few decades. Sustainable mitigation efforts to reduce short-lived climate pollutants (SLCPs), including black carbon, methane, tropospheric ozone and hydrofluorocarbons, will provide more sizable short-term benefits than CO_2 reductions, and reduce warming impacts on the climate (EESI, 2013). The major challenge in energy conservation is, however, not the concept but the economics. Saving money by energy conservation is preferred to saving energy per se. Policies and regulations are also essential ingredients to tackle energy-related emissions.

Energy conservation and efficiency are related but they “have distinct meanings” in the energy world (USEIA, 2019). The former involves using less energy by adjusting our behaviors and habits such as turning the light off when leaving the room, recycling aluminum cans, and reducing the amount of service used (i.e. by driving less). The latter is using technology that requires less energy to perform the same function. To reduce energy consumption and lower our utility bills, we can create an energy-efficient home with LED light bulbs, large household appliances and smart thermostats through technology. Using alternative energy may also enhance energy efficiency and help reduce pollution and greenhouse gas emissions. (See more in Topic #3)

Mitigation with Alternative Energy (Karen Zhang)

Alternative energy is a broad category encompassing all non-fossil-fuel-based energy sources and processes (SUNY, 2016). Forms of alternative energy not covered under the renewable label include hydrogen power and fission power (i.e. nuclear energy). The most common renewable energy sources include wind, solar, geothermal, biomass. We should acknowledge the trade-offs inherent in the production of all forms of energy. A WRI study shows that since 2017, the transportation sector in the U.S., which accounts for the majority of oil demand, has emerged as the largest source of carbon emissions in the country. (Saha, 2019). Renewable energy is not growing fast enough to meet climate goals in the US and globally.

If we are to achieve the United Nations SDGs 3, 7, 11 and 13, ensuring clean and affordable energy for all is vital. It is worth noting that jobs in energy efficiency products and services have experienced significant growth in recent years (SDG 8). Like exponential technologies, renewables such as solar and wind will "power exponential growth" as Ramaz Naam described (Naam, 2019). The future of renewable energy is promising as the U.S. renewable energy prices continued to fall to record lows in 2019 (Marcacci, 2020). As prices fall, more funds will be tapped into new markets and thus increase demand. More demand (and production) will drive prices down, forming a virtuous cycle (Figure 1). Power storage is the missing link in green energy plans. A bid for better batteries and sound policies and regulations on renewable energy will significantly help mitigate global warming.

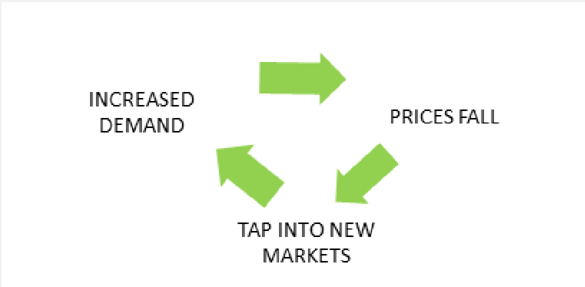

Figure 1 – Demand | Pricing Cycle

Mitigation by Pricing Carbon (Garrett Davidson)

Placing a price on carbon can be accomplished using two methods; carbon tax and cap and trade. Carbon tax puts a price on GHG emissions so that companies are charged a predetermined amount per ton of emissions produced. Cap and trade sets a maximum amount of emissions "allowances" per year. The allowances are then purchased by companies and can also be traded on the secondary market. Under both circumstances, the price put on carbon would hold producers accountable for their emissions and the resulting damage to the public; thus eliminating the tragedy of the commons. The cost would also be an incentive to transition to clean energy technology. Consumers, especially the low income population, will feel the impact of the rising costs, however the revenue generated from the tax or auctioned allowances can be returned or invested in technology (Center for Climate and Energy Solutions, 2009). Funds established by climate justice efforts will help support that redirection of revenue. The best climate policy - environmentally and economically - limits emissions and puts a price on them (Environmental Defence Fund, 2018).

An important difference to consider is how each strategy addresses the overall goals of reducing emissions and the affect market forces have on it. Under cap and trade, a maximum allowance is set and the price is determined by market forces. On the other hand, a tax will set the cost but the overall emissions are subject to the market's willingness to bear those costs. This also helps to understand how economic conditions and government involvement play a role in the pricing of carbon. As the economy fluctuates, the price set on carbon under a tax would have to be adjusted by government action, whereas market forces under cap and trade would adjust the price to fit the overall allowances (Center for Climate and Energy

Solutions, 2009). That means that cap and trade offers the flexibility to adjust on its own as economies grow and shrink. Both methods are currently being used globally, but cap and trade is viewed as having the most impact and has been adopted by the European Union.

Mitigation with Offsets (Dianne Kim)

The efficacy of carbon management strategies is urgently crucial as the 2°C global temperature rise threatens. Amongst these strategies are carbon "offsets" and "insets." Offsets are a means for one to purchase certificates, valued at one metric ton of CO_2 emissions reduction, avoidance, or sequestration (Goodward & Kelly, 2010). These offsets function as an indirect reparation for emissions to counterbalance one's carbon footprint and are typically made by someone else, somewhere else - often indigenous people and the rural poor in developing countries (Clark, 2011). Conversely, insets target the supply chain for reduction, avoidance, or sequestration – a direct, deliberate internal tidying of emissions by focusing on increased efficiency, demand reduction, and increased product sustainability.

Unfortunately, insets are not always sufficient to neutralize total emissions. When this occurs, offsets, such as investing in environmental projects and deforestation prevention, can close the gap. But, who is minding the offsets register? Carbon credits are currency, and it seems creative accounting and lack of transparency abound. Why aren't all credits bought and retired to avoid double counting? Who monitors these projects and forests to determine if public disclosures of implementation and prevention are accurate? Perhaps a global governance structure would lend credibility and reveal the actual benefits of carbon offsetting as a legitimate climate change mitigation approach.

In the meantime, two questions arise. Has the market for offsets created a perverse preservation lock-in that sentences indigenous people and the rural poor to poverty? What are they to do when the colonial minded capitalists come knocking with incentives to use their land and employ their people?

Carbon Capture (Alexander Walters)

Carbon capture is the process of Carbon Dioxide Removal (CDR) from the atmosphere via technology and storing or sequestering it back into natural capital for long periods (i.e. decades, centuries, millennia, etc.) before it is released back into the atmosphere. Research indicates to achieve a stabilized atmospheric content of 350-440 parts per billion (ppm) Carbon Dioxide (CO_2) by 2050 we must reduce emissions by approximately 30-85% (IPCC, 2007).

Given current reduction efforts are not on track to meet this target, human innovation has created carbon capture technologies (more commonly known as Negative Emissions Technologies (NET's)), a technology that sucks the carbon from the air itself. The mechanism used for capturing CO_2 from the air depends on the NET utilized, but pertinent technologies include afforestation, biochar, soil carbon management, enhanced mineral weathering on land or sea, ocean fertilization, bioenergy with carbon capture and sequestration (BECCS), or direct air capture and sequestration (Pasztor et al., 2016).

Beneficial outputs of this technology include reduced greenhouse gas emissions, immediate results, increased natural capital, better carbon management, and alternative energy production. In contrast, prominent drawbacks of this technology include scalability issues, lack of regulatory framework, expensive funding, land use issues, biodiversity loss, and drawn out result periods. With us tiptoeing on crossing a climate change threshold or being forced to implement technological solutions to combat climate change, exploring further development of NET's may prove advantageous. For example, Climeworks, a Swiss-based company has successfully piloted a carbon-negative power plant that extracts CO_2 from the pipes and mixes it with water before injecting the water deep into the ground (Rathi, 2017). Advancements like this prove promising to aid in facing climate change yet face huge barriers to become scalable.

Adaptation and Resilience (Megan Fink)

If it is possible for us to imagine a world in which we reach more than 450 parts per million (ppm) of CO_2 in the atmosphere, then we must plan to adapt. We will need policies and reforms to make our communities resilient in the face of climate-related shocks. Extreme temperatures, rainfalls, and severe weather trends are already starting to appear. Mitigation is a much more appealing term. Adaptation implies that the time has come to cut our losses.

Unfortunately, science is telling us we might not have a choice. "Adaptation goals can often be achieved through better management of ecosystems and investments in natural capital, and at a fraction of the cost of physical and engineering solutions," according to a World Bank Group working paper (WBG, 2016). Nevertheless, "the reality . . . is that people don't want to move and will resist adaptation when it affects things they care about—their jobs and their homes —even if they're no longer sustainable" (Stutz, 2009). Effective adaptation must consider local geography and natural infrastructure, whereas mitigation strategies can have global impact; for instance, "one less coal-powered plant in China has the same effect as one less plant in the U.S." (Stutz, 2009). We must be ready to do both.

Climate Engineering (Dianne Kim)

"[W]ell before it was seen as a potential weapon against global warming, weather modification was simply seen as a weapon" (Klein, 2014).

Because of our collective failure to cut emissions to keep Earth within the global carbon budget, we are giving voice to treacherous Climate Engineering (CE) strategies that allow for business as usual. Scientists, academics, and policymakers alike have turned their attention to calculated technological interventions designed to counter the adverse effects of climate change by removing carbon dioxide from the atmosphere and managing solar radiation (CDR and SRM, respectively). The two approaches are significantly distinct. If CDR is a well-behaved, wall-flower, SRM is the boorish, rowdy flip side of the CE coin - a potential "Wild West" of research (Klein, 2014) if left ungoverned.

CDR has promise in quietly sequestering CO_2 in plants, soils, and oceans even though it is hard to scale, costly, and has a protracted timeline. SRM, however, entails radical schemes to reduce the amount of heat that reaches the Earth, like adding particles into the atmosphere that reflect sunlight into space; and as such, has indeterminate teleconnection implications of potentially disastrous proportions. Many agree that "CE is a terrible thing to need to consider" (Pasztor, Nicholson & Morrow, 2016). Will our love affair with 'business as usual' blaze a trail to the holy grail of climate change mitigation or unleash a torrent of butterfly effect chaos?

Climate System Maps

Climate System Maps show the key strategies for addressing climate change and their interactions, leverage points and trade-offs. As a team, we selected one and decided to enhance it with our collective input.

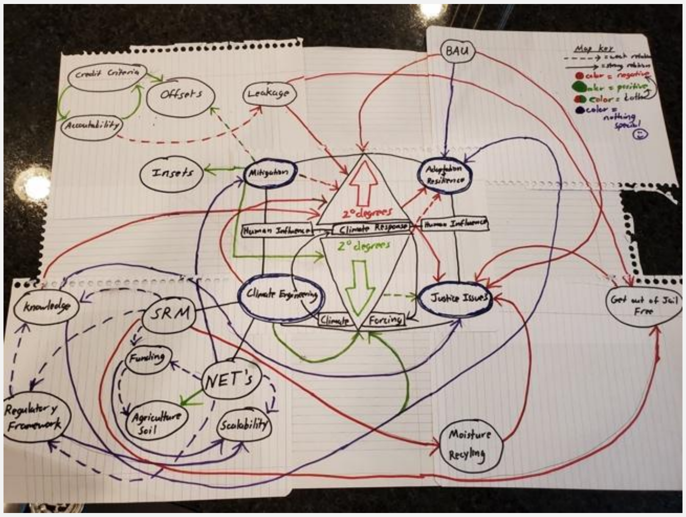

Figure 2 - Alexander Walters

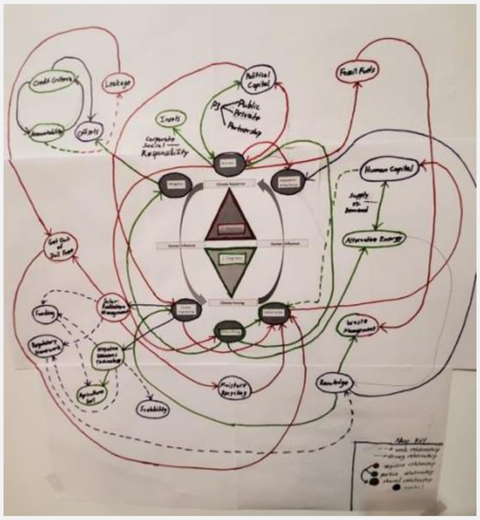

Figure 3 - Team 1 Collective

Climate System Strategies Funding Allocations

Decision Criteria:
The clock is ticking on the wicked issues impacting our Climate. We need innovative, scalable solutions, and we needed them yesterday. Therefore, our decision criteria must be pragmatic and proactive. The following three considerations played key roles in determining our funding allocations:

- The assumption that we will not be able to stave off a global temperature increase of 2°C.
- Impact on SDGs as informed by the "Blueprint for Business Leadership on the SDGs" report, which allows us to see the potential for positive impacts by investing in a particular SDG while at the same time showing us where we should look to minimize our risk of negative impacts. (UN Global Compact, 2017.) See example for SDG 13 in Figure 4.
- The ability to leverage the economy as a driver of fast, large-scale change and enable us to address the immediate needs of intragenerational equity.

Within the US, the biggest leverage point for creating the fast-paced change required to address our Climate Crisis comes from economic incentives via pricing carbon. Carbon pricing will force industries and governments alike to find ways to reduce their carbon footprint. The revenue generated from this pricing can then be invested in renewable energy, justice, and adaptation strategies; thus, prioritizing SDG 1, no poverty, SDG 7, affordable clean energy, and SDG 13, climate action.

Figure 4 – Climate Change SDG Interconnectedness

Allocation Table

STRATEGY	US $ ALLOCATION
Climate Justice	20
Mitigation with energy conservation	0
Mitigation with alternative energy	20
Mitigation by pricing carbon	35
Mitigation with offsets	0
Carbon Capture (i.e., NET)	5
Adaptation and resilience	20
Climate engineering	0

Figure 5 – Climate Change Strategy Resource Allocation Table

Allocation Explanation:

Our largest allocation of funds went to mitigation by pricing carbon based on its strength as a leverage point within the climate system and on SDGs, its ability to limit carbon emissions through economic incentives, and the ease of rapid implementation on a global scale. By implementing cap and trade or a carbon tax, market forces will encourage corporations to seek clean, inexpensive energy options, and we can fund research and development of our next three highest allocations: mitigation with alternative energy, climate justice, and adaptation and resilience. Making the shift to alternative energy sources is crucial to reduce GHG emissions. It also provides positive impacts on many other SDGs including 1, 3, 8, 9, 10, 11, and 13. Mitigation by carbon pricing is one of the strongest options for intragenerational equity and climate justice because it ensures that those who are polluting the most pay the price for their pollution. Funds received from tools like pricing carbon can then help developing countries grow their economies sustainably, using green technologies and infrastructure. Each of these three options provide an opportunity to take advantage of P3s to help drive local solutions through partnerships and model Corporate Social Responsibility (CSR).

Due to our assumption that we will not be able to avoid a global 2°C temperature increase, we felt adaptation and resilience was an important allocation. Adaptation will remain necessary even if we do stay within the 2°C temperature increase. Committing funds to that effort will provide alternative solutions beyond mitigation. We allocated zero funding for mitigation with energy conservation, offsets, and Climate Engineering. The risk associated with both the consequences of unforeseen impacts of Climate Engineering and successes used for nefarious purposes, led us to the opinion that funds can be better used elsewhere. We viewed mitigation with offsets as a strategy that simply robbed Peter to pay Paul and left too much room for climate injustice. Finally, mitigation with energy conservation would require effort to change consumer behavior; something that has proven to be very difficult, if not impossible.

Climate System Summary

The individual challenges faced by different nations across the world are only multiplied when the consequences of human development on climate change begin to reveal themselves. Whether it is hunger, political unrest, social justice, etc., the interconnectedness of these issues proves to be even more difficult when balancing economic development and prosperity. In an ideal, ecomodernist world, the economy would be decoupled from the environment, but how do we get there? Is staying below the 2°C limit even possible? Ultimately only time will tell, however it will be necessary to focus on a combination of mitigation and adaptation strategies.

A balanced approach comes with trade-offs, and our bandwidth as a society puts limits on how much time, effort, and money can be invested into these different options. Whether we break the global CO_2 budget or not, we cannot exist without both a thriving economy *and* environment. We must build both intra *and* intergenerational equity. We must hold GHG producers accountable *and* provide climate justice. Climate change is the great threat multiplier, but successfully correcting our course will act as a positive lever to pull for supporting all sustainable development goals.

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