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POLICY BRIEF
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CLIMATE CHANGE AND ENERGY:
Interrelationships and Possible Policy Approaches

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Today one can hardly read a newspaper without a mention of climate change. While evidence of climate change proliferates throughout the world, the policy approach to the issue is disparate across the world and county. Climate change is altering the world's weather patterns, and while we do not know exactly how each individual area will be affected we can expect the continued climate change due to continued release of emissions. This paper presents a research-based review of the issue and possible policy directions. Here we report the scientific understanding of the problem and offer policy directions for policy makers including those in rural areas.

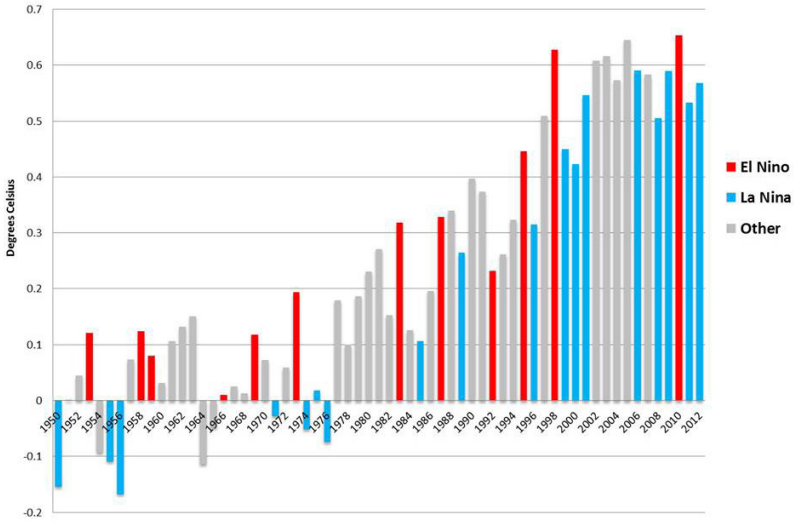

Figure 1. Annual global temperature anomalies 1950-2012. The figure is from NOAA, State of the Climate, Global Analysis - Annual 2012, http://www.ncdc.noaa.gov/sotc/global/2012/13.

WHAT IS HAPPENING

The world is facing growing global temperatures (Figure 1). Eleven of the twelve warmest years on record have happened since 2000. The United States experienced its warmest year on record in 2012. Global sea levels are rising. Scientists have recently estimated that ice that took 1600 years to form in Peruvian glaciers completely melted in the last 25 years. Rainfall patterns are changing. Drought is becoming more common. Weather is becoming more extreme, leading to ever-more costly events, including in the agricultural sector. For example, the 2001 U.S. Southwest drought resulted in a net loss of $7.6 billion. All of this is a reflection of the fact that we are in a period of rapid climatic change. These climatic changes affect rural development because rural activities often are highly dependent on climate change vulnerable ecosystem services.

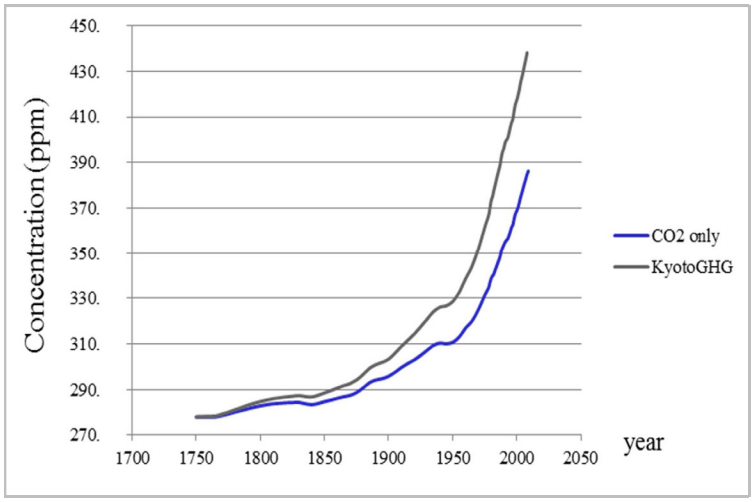

Figure 2. Expansion of GHG emissions 1750-2007 for carbon dioxide and all GHGs. Figure adapted from IPCC report (2007).

FACTORS AND POSSIBLE MITIGATION

Recent findings suggest carbon dioxide and other greenhouse gases (GHGs) are causing climatic change by increasing the retention of heat in the Earth's system. Globally 69 percent of the greenhouse gasses originate from energy consumption. Additionally 14 percent arise from food production and 17 percent from deforestation. Meanwhile, energy use, food production and land-use changes with their resulting emissions generally expand with incomes and population. In fact, global GHG emissions have been rising at an increasing rate (Figure 2). Society has tried to mitigate GHG emissions but is making slow progress and global participation is required.

Climate stabilization requires that emissions peak, then drop to low levels approximately five percent of today's US levels. Unilateral action by any one country would not be effective and thus emissions mitigation has to be a global endeavor.

WHAT IS PROJECTED

Given the likelihood of not only continued but also rising GHG emissions, climate change is projected to persist. Projections indicate further temperature and precipitation changes, accompanied by many other environmental changes. In turn, this would cause widespread disruptions, including changes in fresh water supplies, the extent of snow pack, location of agricultural crop production zones, frequency of extreme event incidence, sea level rise and the inundation of coastal infrastructure, increased incidence of pests and diseases, and altered ranges of birds and plants. It is estimated in The Stern Review (2006) that no action would mean a loss of five percent of global Gross Domestic Product.

POLICY LANDSCAPE AND FOSSIL FUEL RELATIONSHIP

There are three broad policy approaches to the climate change issue (Figure 4). One involves investing in learning more about and monitoring the effects, and two are damage reducing response directions. One involves reducing society vulnerability to the effects which is called adaption; and one is to reduce the causes, or mitigation. Mitigation involves actions aimed at reducing climate change drivers like greenhouse gas emissions, which are designed to limit future climate change. Adaptation involves reducing the negative effects of climate change and exploiting the positive ones. Note these three basic policy directions are not mutually exclusive with all being used. Now we elaborate with a bias towards our areas of expertise: energy and agriculture.

Investing in Climate Information

Policy makers could fund monitoring activities that inform us about the effects and observed consequences of climate change. This may involve large or small investments at both the large and small scale. It also may involve waiting for effects and causal mechanisms to become apparent. Information gathering is essential and will reduce uncertainty on needs for mitigation and adaptation. However, over-reliance on an information only approach may lead to delayed responses to climate change that in turn cause substantial damage, some irreversible.

Mitigation Activities

Society can act to limit GHG emissions and atmospheric concentrations. The National Academy of Sciences (NAS) outlined a suggested portfolio of approaches to such an endeavor:

- Adopt a mechanism for setting an economy-wide GHG emission pricing system.
- Complement this with increases in: a) energy efficiency; b) reduced emissions from energy use in electricity production and transportation including carbon capture and storage plus evolutionary nuclear technologies; and c) retirement, retrofit or replacement of emission-intensive infrastructure.
- Create new technology choices.

Furthermore, the NAS advocated a) policies that promote equitable outcomes with attention to disadvantaged populations; b) establishing the US as a GHG reduction leader; c) encouraging regional and state policy exploration; and d) balancing policy durability and consistency with flexibility and capacity for modification.

From an economist's perspective a few points can be made about these recommendations. The GHG emissions are an externality, in that GHG emissions are not deliberate acts on behalf of emitters. Rather they are byproducts of production and consumption that are not really factored into decision maker choices.

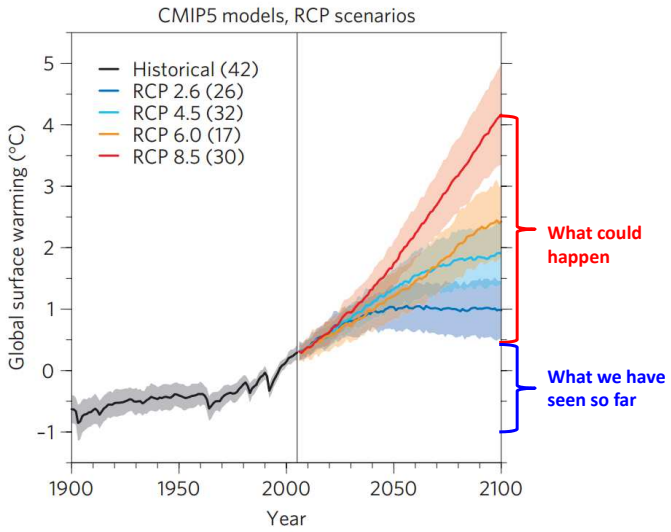

Figure 3. Global temperature change from new CMIP5 climate model projections, Adapted from Reto Knutti and Jan Sedlácek, Nature Climate Change (2013).

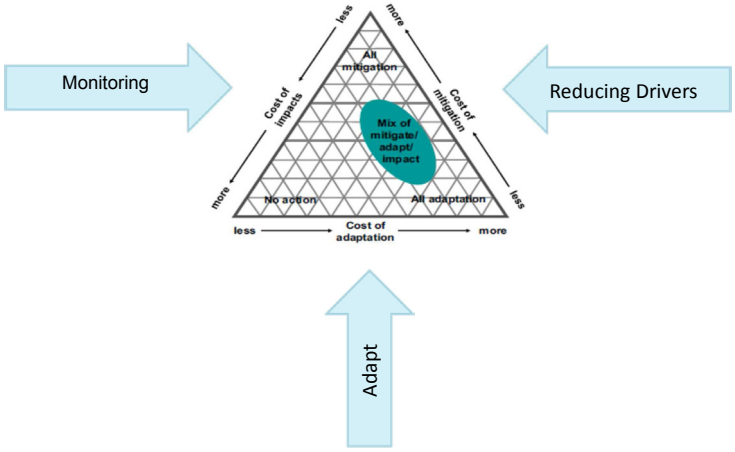

Figure 4. Three elements of total burden of climate change. Adapted from Parry et al 2009.

When such emissions cause harm to others the standard economic approach is to charge the emitter for the harm in turn influencing choices. Thus a carbon price would be intended to reflect the harm done by GHG emissions. In turn the emitter would have incentives to reduce emissions and could provide substantial incentives to innovate in controlling emissions.

There are a number of ways a price can be applied. One may limit emissions through regulation, in which case the price is foregone income or consumer satisfaction. Alternatively one can impose an emissions tax which would provide certainty on emissions cost but yield an uncertain quantity of emissions reductions. Finally a hybrid system can be implemented, whereby people are allocated rights to generate emissions but with the rights being tradable (a cap and trade scheme) where the private market sets the emissions price. Then total emissions are controlled but there is substantial emissions price uncertainty. Also under that system, low cost emission reducers are likely to trade with higher cost emitters, reducing overall program cost. The Kyoto protocol advocates such a scheme and spawned the multi-sector, multi-country European Union's Emissions Trading Scheme (EU ETS) in 2005.

When imposing a price or emissions limits, care must be taken to avoid large government-borne implementation costs or private market participation costs. This may involve imposing the price and reporting requirements either on the emissions producer or in cases upstream or downstream. Additionally, comprehensiveness of the system is important. Greenhouse gas emissions come from forest clearing, agricultural soils, fertilizer use, point industrial processes, and a diverse mix of nonpoint sources. Schemes need to be worked out to treat this as much as possible in a cost-effective manner.

Economists favor pricing systems as they provide an effective and efficient way to deal with reducing carbon emissions that incentivizes innovation. Additionally the cap and trade system incentivizes the lowest-cost form of reducing carbon emissions. Subsidies and other public policies are not as efficient but may be necessary until cap and trade becomes politically feasible

Mitigation actions can be done by both public and private parties. Given greenhouse price signals, there will be private industry responses. However, some mitigation activities require substantial investments, such as capturing carbon emissions from power plants that, once developed, are likely to spread widely throughout the industry. In those cases, industry cannot privately capture the full benefits of their investment and as a consequence are likely to underinvest. Similarly, new mitigation strategies may need to be brought to the attention of emitters. Collectively these imply a public-sector role in development and dissemination of mitigation technologies.

Adaptation Activities

Growing population and rapid development of countries like Brazil, Russia, China, and India have caused greenhouse gas emissions growth and will almost certainly continue to do so. Note, Figure 3 shows colored lines that represent the consequences of alternative mitigation choices and that, even under the most stringent of those, there is still substantial warming by 2050. This means climate change will continue and that climate change adaptation actions are likely inevitable.

In agriculture, there are many available adaptation options, including changes in crop mix, adjustment in land use, development of irrigation systems, introduction of new heat and drought-resistant plant species, use of better fertilization techniques, and changes in planting/harvesting dates. Private decision makers will undertake such adaptations when they are to their benefit. For example, Figure 5 shows a northwestern shift in corn and wheat acreage over the last 60 years as the climate warmed. Note some adaptation options are constrained by equipment inventories where for example more efficient technologies may not be adopted until equipment replacements are in order. Public adaptation can also be involved including

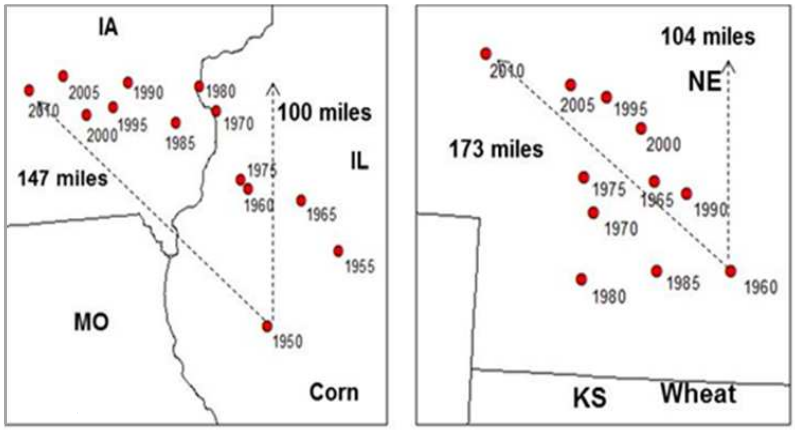

Figure 5. Adaptation in form of northwestern shift in crop mixes. Figure drawn from Attavanich et al (2013).

actions such as: a) research and development on options, b) technology dissemination, c) infrastructure construction, and d) subsidies in general supporting private action providing possibilities, information, and cost relief.

POLICY ROLE

Collectively, the effects of climate change will also depend on policy decisions with public actions possible on information gathering, mitigation, and adaptation. Such actions require investments and need to be traded off against competing uses of public funds.

Clearly a mix of information gathering, mitigation and adaptation is in order. More specifically in terms of information it would be useful to charge local agencies with:

- Reviewing evidence on how much climate has changed and in what ways.
- Assembling projections for the region on likely climate change.
- Examining historical data on water, crop yields, crop mixes, livestock numbers, pest incidence and other items and analyzing them to discover climate related patterns.

In terms of adaptation:

- Given information on climate change and yield pest changes etc. develop recommendations on likely needed adjustments in next 10 years in crop, and livestock adaptation plus implications for infrastructure development, and information needs.
- Encourage R&D to address critical adaptation needs.
- Consider improving infrastructure to improve adaptation and resilience.

In terms of mitigation:

- As industry, housing, energy generation, transportation fleet development and turnover proceeds encourage more greenhouse gas emissions reducing technology.
- Promote energy efficiency, conservation, reduction of emissions from emission intensive locations.
- Consider taking a position of emissions reduction leadership with emissions pricing and emissions reduction technology promotion.

Additionally, policy makers should realize that policies may need to vary substantially by region (e.g. solar panels may be a good initiative in one region but not in another). R&D is also critical in developing new strategies to monitor, adapt, and mitigate . In addition to comparing the alternative uses of government funds, a general benefit-cost analysis should be done regarding the desirability of various climate change policies.

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