'The importance of climate change is now widely accepted...what is less widely accepted is what needs to be done. In the wider scientific context, the gulf between the scale of the problem and current objectives and measures is enormous.'

What roles are there for international policy, economics and governance to play in reconciling the various differences thus identified?

Much current, scientific and political discourse concerns the existential threat posed by climate change, wherein 'Man's institutional capacities to manage the earth's ecosystems are evolving more slowly than his overuse of the same systems' (Folke, 2007). Indeed, observing normatively the architectures of climate change adaptation and mitigation (IPCC, UNFCCC), it is evident that they have evolved too slowly since the Kyoto Protocol (1997) to bridge the widening 'metabolic rift' (gulf) between nature and society. The general properties of this rift are the systematic degradation of the biosphere, disruption or interruption of natural processes and cycles (fossil fuels on CO2; agriculture on CH4) and the accumulation of waste and environmental degradation. Yorke (2005) places the 'rift' in a historical context, he writes: 'due to capitalism's inherent expansionary tendencies, technological development [since the Industrial Revolution] has escalated commodity production - necessitating the burning of fossil fuels to power the machinery of production - [and in doing so] flooding carbon sinks and generating an accumulation of CO2 in the atmosphere.' Central to this spiraling, exponential trajectory - CO2 is up 40% since pre-industrial times - is Jevons Paradox, wherein technological improvements actually increase the amount of resources used, since expansion in production typically outstrips gains in efficiency. Emerging from the paradox are the realities of climate change and the widening 'gulf between the scale of the problem (global effects, time ticking) and current objectives and measures' of response (Held, 2005).

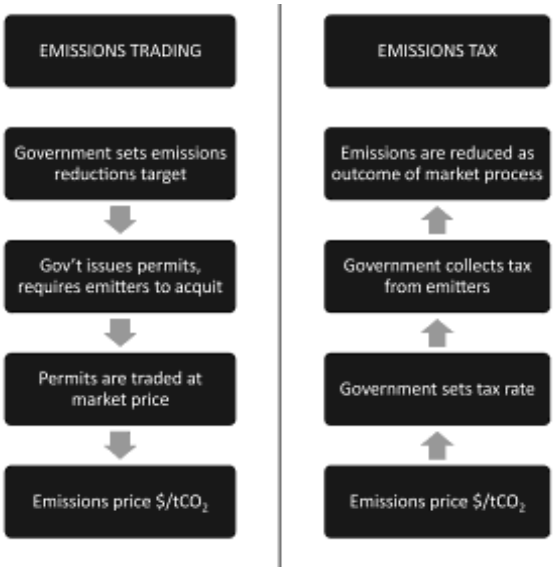
Fundamentally, the IPCC (among other global, national and sub-national institutions) attempts to heal this metabolic rift through legislative (emissions tax) and regulatory (emissions trading) apparatuses that might alter pollutive incentives and thus social behaviours globally (in the spaces of production (east) and consumption (west)). That this Kyoto (IPCC) architecture of climate change adaptation/mitigation has faltered, or evolved too slowly, is reducible to several complications at its birth: (i) lack of participation/accountability: four of the five largest emitters are de facto not restrained by the protocol: China and India, as they are not parties to the relevant annex; the US due to non-ratification; and Russia as a result of having received such generous targets (functions overlapping; mandates conflicting); (ii) time frame/incentives of compliance: its five year time horizon (2008 - 2012) - represents a relatively short-term approach for what is fundamentally a long-term problem. Subsequent accords - Copenhagen (2009), Doha (2012) - have been plagued by similar political constraints, Held (2005) suggests that the Kyoto Protocol is a maturing technocratic architecture, marked by growing political differentiation and fragmentation (anarchic inefficiency) - 'the spirit is willing but the flesh is weak" (good policy spoiled by partisan implementation) and the "healthy body blighted by madness" (decision-making processes crippled by particular interests).' I would suggest that, more than maturing, Kyoto is senile and has reached saturation point wherein now there is space for succession and the creation of a 'scientifically sound, economically rational, and politically pragmatic' post-2012 international climate policy architecture (Aldy et. al, 2008).

Primarily this essay explores the future roles for international policy, economics and governance within an idealised, post-Kyoto architecture of democratic, adaptive management wherein, 'discursive designs involve collective decision

making through authentic democratic discussion, open to all interests, under which political power, money and strategising [praxes of the present system] do not determine outcomes' (Held, 2005). Such an architecture is already unfurling organically at the pillars of Kyoto, characterised by: (i) the coexistence of multiple and diverse epistemologies/frameworks of interpretation (such as the transparent 'epistemic community' (Haas, 1990) and Earth System Governance) (ii) renewed focus on global-local linkings (building trust between actors of state and civil society: hazards research; REDD+ and the 'localisation of regulation' (Gunningham, 2009) (iii) continuing assimilation of nature into socioeconomic processes (pragmatic IPCC policies of emissions tax and trade) and (iv) sustainable development (poverty alleviation, spreading ideas of resilience, renewal and the social-ecological memory of Kyoto). This latter point is significant; a post-Kyoto architecture must retain fragments, or memories, of its predecessor, and in particular, the targets of emission reduction and two key moral principles written in by the UNFCCC in 1992: the precautionary principle and the principle of common but differentiated responsibility. The former assumes that where there are threats of serious or irreversible damage, uncertainty shall not be used as a reason for inaction, and the latter; that while all countries should protect the climate system for present and future generations, developed countries (Annex 1) should take the lead in combating climate change as they bear the greatest responsibility for historical emissions and have the most capacity to respond.

The fundamental objective of the United Nations Framework Convention on Climate Change (1992) is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. (United Nations, 1992). To achieve this objective, as the IPCC (2013) writes, requires a global policy framework through which emission reductions can be coordinated. Current climate change architecture(s) are framed around two dichotomized philosophies surrounding the scale and timeframe of its implementation. Stern et. al (2006) suggest a global commitment to mitigation requires a relatively rapid instistutionalising of a global carbon mitigation system that is highly integrated across economies. In contrast, Mckibben (2007) proposes that such a fully integrated global system is not feasible (and could be detrimental to sustaining effective policy in key countries) and that it would be more realistic to focus on creating national systems of mitigation that are (loosely) coordinated through the UNFCCC process to build up to a global system.

The policies advocated by those who support the comprehensive global approach include a global emissions trading system whose permits are freely traded between countries, or a common carbon tax to yield a global carbon price. The alternative approach (Mckibben, 2007) proposes the creation of national policy frameworks involving carbon taxes, national cap and trade programs (with safety valves) and/or direct regulation around a set carbon price. The current system, as Brown (2011) posits, sways more towards this alternative, fragmentary and gradualist framework wherein 'separate parties are focused primarily on cap-and-trade systems to control emissions...the European Union implementing its system; the USA and Australia, among others attempting to enact their own.' There is also a gradual integration occurring between the systems, facilitated by several mechanisms of the Kyoto Protocol that allow a nation to seek credit for emissions reductions outside its borders; Jaeger et. al (2012) delineate three: (i) the Clean Development Mechanism (CDM) that provides for Annex 1 Parties ('developed' economies) to implement projects that reduce emissions in non-Annex 1 Parties ('developing' economies) or absorb carbon through afforestation/reforestation



Financial Mechanisms of mitigation/adaptation (Kasperson et. al, 2010): Emissions trading (market approach); emissions tax (government approach)

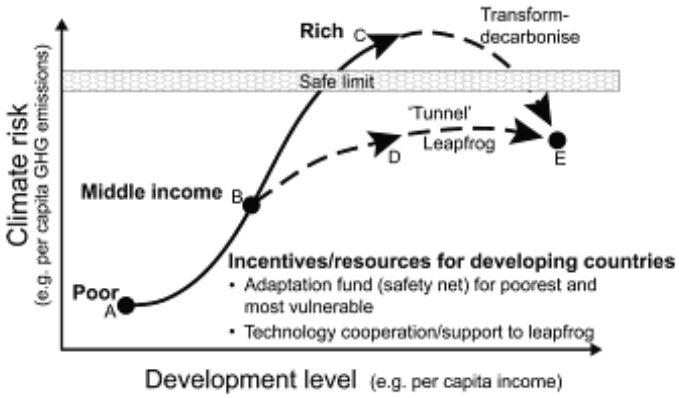


Figure 2 A new Rostow's model? Pathways of economic development that integrate climate change mitigation (Richardson et. al, 2011)

activities, in return for certified emission reductions; (ii) the Joint Implementation Mechanism: an Annex 1 Party may implement an emission-reducing project that enhances removals by sinks in the territory of another Annex 1 Party and count the resulting emission reduction units towards meeting its own Kyoto target and (iii) Emission Trading Schemes that provide for Annex 1 Parties to acquire units from other Annex 1 Parties and use them towards meeting their emissions targets under the Kyoto Protocol. This enable parties to make use of lower cost opportunities to reduce emissions, irrespective of the Party in which those opportunities exist, in order to lower the overall cost of reducing emissions.

The latter mechanism - carbon trading, or cap and trade - attempts to limit pollutive practices (the tragedy of the commons) through the creation of property rights to environmental resources. The EU Emissions Trading Scheme (ETS) provides incentives for individuals/firms to conserve their environment by clarifying their rights to and responsibilities for common property. The tradeable permits act as quotas, allowances or ceilings on pollution emission levels that, once allocated, can be traded subject to a set of prescribed rules. The ownership of a tradeable permit allows a firm to pollute up to a certain limit. If the firm wishes to expand production, then they must either invest in pollution control equipment or purchase more permits. Firms which choose to emit less than their allowance may sell their surplus permit to other firms or use them to offset excess emissions in other parts of the plant. In this pollution control regime, firms with the lowest abatement costs have an incentive to control more emissions, and those with high abatement costs have an incentive to buy permits instead of investing in costly pollution control equipment. The market is thus left to determine the most efficient way to control pollution within a regulatory framework. Such exposure, or reliance on the market, has led to several criticisms of Cap and Trade policies, in particular the volatility of carbon prices, Carrington (2013) writes: 'lobbying by [carbon-intensive] industry and a huge oversupply of permits, owing to global financial crisis, has caused production to drop and the carbon price to crash over recent years.' In contention, Elliot (1998) frames Emissions Trading Schemes more optimistically, suggesting that further progress is reliant upon: (i) the continuation of tightening regional emissions caps with fixed annual reductions (ii) increases in mandatory auctioning of allowances and (iii) expansion of legislation into further pollutive industries.

Emissions taxation, in contrast to carbon trading - placing property rights on environmental resources - directly manipulates the price of pollution though government legislation. Olmstead (2011) proposes that taxation 'eliminates

the political and ethical shortcomings of a carbon market, characterised by price volatility and asymmetries of knowledge/exploitation between private and public actors.' The argument for simplicity (of government) over complexity (of the market) is supported by Grant et. al's (2000) research on the effectiveness of European Union environmental policy, they posit: 'the scope and urgency of environmental problems typically exceed the capacity of private markets and individual efforts to absorb them.' Market failure is thus corrected through green taxation that internalises the marginal social cost of pollution. Eichner et. al (2010) furthermore elicit the correlation between green taxation and green (renewable energy) subsidisation, theorising the European Union, they write: Without green subsidies, the emissions tax is set inefficiently low, since each country ignores the environmental externality inflicted on other countries and since the emissions tax leads to a capital outflow to other countries [Brussels]. When the green subsidy is available, countries choose a positive subsidy rate since this reduces the overall distortion of the tax-subsidy system. In doing so, each country internalizes a larger part of the environmental externality. As consequence capital is relocated from the dirty into the clean sectors and reduces global pollution. Hence, the subsidy is not only beneficial for the country which imposes it but for all countries of the European Union (Eichner et. al, 2010)

The capital raised by emissions taxation further support programmes of subsidisation in the Clean Development Mechanism (CDM) wherein green technologies, scientific and technical expertise are transferred - at concessional 'developmental' rates - form Annex 1 Parties ('developed' economies) to non-Annex 1 Parties ('developing' economies). Elliott (1998) sees space for further integrating of mitigation into development pathways by making development more sustainable through pathways (Figure 2) which promote decarbonization (C - E) and leapfrogging (B - D - E). He furthermore places the future effectiveness of 'redistributive justice' and climate change mitigation in the 'strengthening of mitigative capacity' (defined as the ability to reduce GHG emissions or enhance sinks) by building social, political and economic structures (Figure 3) and conditions, and by supporting social learning, education and innovation. In evaluating climate policy architectures, the IPCC recognises 6 criteria: (i) environmental outcome, (ii) dynamic efficiency (maximises the aggregate present value of net benefits of mitigative action, (iii) dynamic cost-effectiveness, (iv) distributional equity, (v) flexibility in the presence of new information, and (vi) participation and compliance. Of the current Kyoto architecture - one deeply saturated in the economics of emissions trading and taxation - it could be argued it scores highly on dynamic cost-effectiveness (through the creation of market-oriented institutions) and distributional equity (CDM; subsidies). However, its anarchic inefficiency and political infighting/slow bureaucracy causes it to score low on the remaining: environmental outcome, dynamic efficiency, flexibility in the presence of new information, and participation and compliance. The remainder of this essay explores how Post-Kyoto architecture(s) might draw to high equilibrium all six of the criteria.

The architectures of climate change mitigation/adaptation operate in a complex, global space where 'where actors are more diffuse, decision-makers widely distributed, intermediaries shifting and in conflict, and the media contributing to amplification and attenuation of the signals to decision-makers and society more generally.' For an effective, post-Kyoto architecture to evolve, Kasperson et. al (2011) suggest that novel epistemologies, or a new kind of science to narrow the gap between science and practice, must emerge. Indeed, scientific uncertainty (and skepticism) in the mechanics of the climate system challenge the very ontology of global warming. Bostrom (2008) delineates three typologies of knowledge in science-policy interactions:

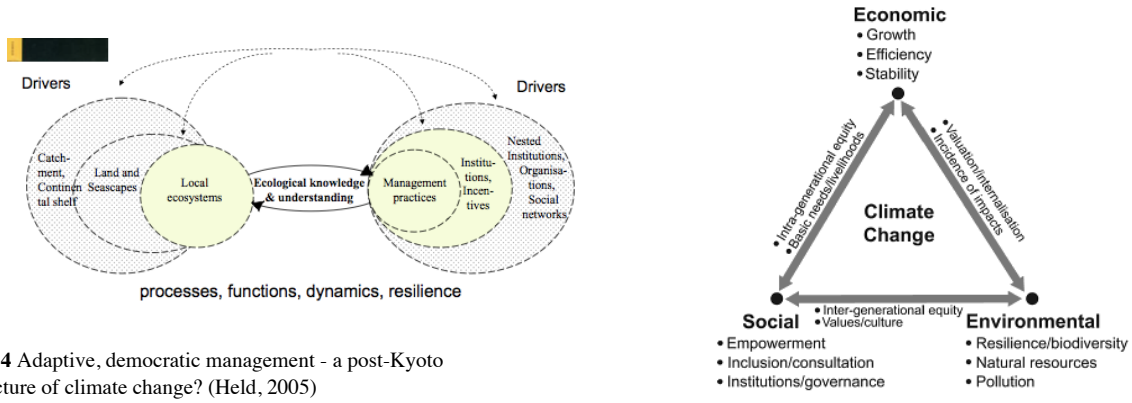


Figure 4 Adaptive, democratic management - a post-Kyoto architecture of climate change? (Held, 2005)

instrumental (science delivers data and establishes causalities), conceptual (science delivers new ideas), and symbolic (science legitimizes decisions already taken). 'Our Common Journey' (1999) concludes that 'tensions exist between broadly based and highly focused research strategies; between integrative problem-driven research and research firmly grounded in particular disciplines; and between the quest for generalizable scientific understanding of sustainability issues and the localised knowledge of environment-society interactions.

In contrast to the current command-and-control mode of governance in Kyoto architectures, Peter Haas suggests the notion of epistemic community, an alternative that emphasises culture and informal processes over structure. In his work on the development of a plan to address pollution in the Mediterranean basin, Haas (1990) charted the evolution of an interactive network of scientists and policy makers in conducting assessments and formulating an integrative science and risk management policy for the Mediterranean Basin. He calls particular attention to the creation of extensive personal and professional linkages between scientists and practitioners in creating an overall holistic plan for addressing a wide variety of threats to environmental quality in the basin.

While organizational mechanisms evolved to facilitate both scientific assessments and policy deliberations, at base they rested upon the emergence of a knowledge system with a shared conception of problems and goals, levels of personal trust among key actors, and continuing adjudication of the tensions between science and policy. Haas' 'epistemic community' - common knowledge system, shared goals, and ongoing negotiation in analysis and deliberation - has been extended upon in recent years by Helm (2005). Helm frames the current stodginess of climate change governance as a characteristic deeply inculcated in the 'ongoing co-productions between the scientisation of politics and the politicisation of science. To move beyond the quagmire, he argues for an inclusive environmental politics based on the principles of deliberative democracy, wherein (i) collaboration of a diverse set of actors and actor groups operating at different organisational levels is actively engendered, and (ii) there is sharing of governance power and responsibility involving multiple institutional linkages among communities, government agencies, and non-governmental organisations (Figure 4). Such a climate change architecture relies upon the creation of policy dialogue, environmental mediation, lay citizen deliberation, governance networks, and societal dialogues.

Richardson et. al (2011) suggest that at the core of any post-Kyoto architecture must be a research framework that integrates global and local perspectives to shape a 'place-based' understanding between environment and society, they write: 'it would be prudent [given current paralysis] to open climate change science and policy to local communities that have made significant progress in mitigating greenhouse gas emissions or in adapting to already observed climate changes, with or without outside assistance...Such cases exemplify an approach to reducing net losses from climate

change called ‘adaptive governance’, where ‘adaptive’ means responsive to differences and changes on the ground (Richardson et. al, 2011)

This approach further depends on factoring climate change - once conceived as ‘a globally irreducible problem’ - into thousands of local problems , each of which is more tractable scientifically and politically than the global problem. The materialities of this post-Kyoto architecture are already evolving on the ground. Recent advances in the implementation of REDD+ (the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in developing countries) have drawn from this new collaborative environmental governance, Gunningham (2009) conceptualises it as the ‘localisation of regulation’: through the better integration of governance functions at different levels, from international to local; greater collaboration between public, private and civil society actors; and use of a variety of policy instruments, from traditional regulation to market-based mechanisms.

In similar key, IPCC reports have begun to conduct ‘dynamic, holistic, multi-dimensional, multi-scalar and differentiated’ (IPCC, 2013) approaches to their data collection at specific localities. For example, in analysing the historical emissions of Brazil, care is taken to distinguish land-use emissions from livestock emissions, and to weight emissions according to land area. In reiterating the need for a coexistence of multiple and diverse epistemologies, or frameworks of interpretation in the post-Kyoto architecture, Earth System governance emerges, Dow et. al (2011) write: ‘Earth System Governance adds [to current climate change discourses] new connotation that that links institutional research to the eventual core concern of environmental politics: the ongoing transformation of the entire Earth system, from global warming, large-scale changes in biogeochemical cycles to unprecedented rates of species loss...[It] bridges levels from global to local as well as academic communities from natural science-oriented modeling and scenario building to political science and philosophy.’ Critically, Dow et. al recognise the nascency of their post-Kyoto architecture, stating that, whilst it requires ‘more substantiation in research, it might well emerge into a powerful new paradigm that describes the core governance challenge that lies ahead: the long- term transformation of the entire Earth system driven by humankind.