Confronting climate crisis: A framework for understanding the criteria for addressing dangerous climate change

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Abstract.

Despite wide acknowledgement of the threats from human-induced climate change to human societies and the wider ecosystem, no comprehensive long-term global agreement to tackle the problem has yet been reached to replace the Kyoto Protocol. In arguing for a replacement, evaluative claims are often made that certain policy proposals are *more environmentally effective*, *equitable or efficient* than others. However, these three dominant criteria are subject to a range of interpretations, and can come into conflict with one another. This limits their use for guiding policy. Philosophy can and should play a role in scrutinising alternative conceptions, their justifications and assumptions, and help develop justifiable formulations of the criteria. Existing philosophical contributions have focused on aspects of the equity criterion, but have largely overlooked the other two criteria and have not considered how they should be prioritised overall. This thesis, for the first time, considers and proposes an ordering of these three criteria (focusing on mitigation), drawing on a Green Economic conceptual framework. This places ecological effectiveness first, defining the ecological limits of economic greenhouse gas-emitting activity; equity is then applied second, to define equitable resource sharing of the emissions space; and efficiency last, to imply genuinely efficient use of emissions space in contributing to equitable human well-being. The thesis then examines in detail how each criterion should be interpreted within this context, so that they are mutually consistent. As well as offering a set of ordered evaluative criteria for a climate change mitigation agreement, it aims to highlight the role of the conventional political-economic framework in climate policy debates and draw out the hidden conceptual and ethical assumptions it imports. This thesis also, therefore, aims to further the development of Green Economic thinking and show its relevance to the current substantial threat of dangerous anthropogenic climate change.

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Acknowledgements

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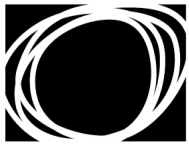

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Introduction

Despite wide acknowledgement of the threats from human-induced climate change to human societies and the wider ecosystem[1], no comprehensive long-term[2] global agreement to tackle the problem has yet been reached. Whilst international wrangling continues over replacing the much-criticised Kyoto treaty, global emissions continue to rise[3] and recent estimates[4] suggest that around 350,000 people already die each year as a result of human-induced climatic changes[5]. Against the background of this dire need for collective action, what possible useful contribution can be made by philosophy, maligned for its tendency to have "interpreted" the world rather than "to change it"?[6]

It is my firm belief that philosophy can make an important contribution to the global response to this challenge. This contribution is both conceptual and normative. Debates about climate policy have, until recently, been dominated by neo-classical economics and frequently invoke pseudo-scientific claims[7] about the merits of particular policy proposals without questioning or, often, even acknowledging the values and assumptions which underlie such judgements[8]. When particular values and principles *are* invoked at a political level: such as requiring

[1] See e.g. IPCC, 2007c, (Summary for Policymakers); Bailey & Wren-Lewis, 2009; Lister, 2009. Although public opinion is variable; US and UK polls in 2010 showed a decrease in public belief in anthropogenic climate change (Goldenberg, 2010).

[2] The Kyoto protocol extends only to 2012, was never ratified by the United States, and only set binding reductions for 37 industrialised countries implying just a 5% reduction of greenhouse gas emissions against 1990 levels by 2008-2012 if successful. Ongoing negotiations for a replacement agreement have currently only resulted in the 2009 Copenhagen Accord and 2010 Cancun Agreements. These simply state the general need for "deep cuts in global emissions... to hold the increase in global temperature below 2 degrees Celcius"(UNFCC, 2010, 2/CP.15; UNFCC, 2011, 1/CP.16) and have not yet specified particular targets for emission reductions, beyond "achieving the peaking of global and national greenhouse gas emissions as soon as possible".

[3] IEA estimates reported in the Guardian (Harvey, 2011) placed total carbon dioxide emissions for 2010 at 30.6 gigatonnes(GT); 1.6GT higher than in 2009.

[4] DARA and Climate Vulnerable Forum, 2010, p12. Although impacts of climate change cannot be "linked to any specific event", the report estimates them statistically "considered an added stress, effect or change", on "pre-existing characteristics of society".

[5] Research for Oxfam also implies that "by 2015 there may be more than a 50 per cent increase" in people "affected by climate-related disasters in the average year" compared to the last decade. (Taylor & Schuemer-Cross, 2009, p25)

[6] Marx, 1845

[7] Highlighted by e.g. Padilla, 2004, p532

[8] Brown, 2002, p236

climate policy to be "on the basis of equity"[9] or prevent "danger"[10], they can remain largely unanalysed, despite being subject to a wide range of interpretation[11]. Philosophical enquiry can contribute through scrutinising competing claims, analysing alternative policy positions, identifying ideological points of conflict, their justification and assumptions, and by advocating and defending particular proposals. Indeed, this need has not gone unnoticed, and philosophical contributions to climate policy debates have grown over the last decade[12].

The particular focus of these contributions has been on alternative principles for equitable distribution of burdens in a global climate agreement[13], although I do not find the conclusions adequate, as I explain in chapter 3. However, philosophical scrutiny has largely overlooked the two other significant criteria normally cited alongside equity to guide climate policy. These are 'environmental effectiveness'(which I reconstrue in chapter 1 as 'ecological effectiveness') and 'efficiency'(ordinarily understood in terms of 'cost-minimisation'), and are increasingly leaned on as the three key criteria that climate policy proposals should fulfil[14]. These also warrant philosophical engagement, but have not yet received the same attention as equity[15]. Therefore, a central aim of my thesis is to distinguish and critique possible interpretations of these three criteria, and offer an understanding for each which should be used to guide and evaluate climate policy proposals.

[9] UNFCC, 2011, 1/CP.16, Section 1.4.

[10] E.g. UNFCC, 2010, 2/CP.15, section 1 refers to preventing "dangerous anthropogenic interference with the climate system".

[11] Whilst I disagree with Hulme in his largely relativist approach to controversy over such interpretations (see chapter 2, section 1), he is right in highlighting that they should be explicitly analysed and considered. See Hulme, 2009, passim.

[12] Most notably Donald Brown, Stephen Gardiner, Simon Caney and Ed Page. However, this has yet to be accommodated into IPCC reports.

[13] E.g. Page, 2008; Caney, 2005.

[14] E.g. Stern (2008, p4), highlights "Effectiveness", "Efficiency", and "Equity" as "three basic principles" for global policy on climate change. Similarly Agarwal (2002, p386), requires "ecological effectiveness", "economic effectiveness", and that policy solutions be "socially just and equitable".

[15] Although aspects of them have received some, through debates surrounding intergenerational justice (Caney, 2008), discounting (Padilla, 2004) and criticism of climate change policy's reliance on cost-benefit analysis (Brown, 2002).

Yet these three criteria cannot be considered as wholly independent. For, as I consider in chapter 1, section 0.1, they can conflict. How such trade-offs should be approached is at least as significant for policy as how each criterion is singly interpreted. Analysis is, therefore, also needed of how they might be prioritised or, alternatively, as I pursue in chapter 1, how the criteria might be framed so as to be mutually consistent. Any framework to guide international climate policy on dangerous anthropogenic climate change (henceforth DACC[16]) will involve exploration of the structure of the problem. Although, therefore, the ultimate goal of this thesis is to examine interpretations of the three central criteria for an agreement, this is set within the context of developing a particular conceptual approach, which I apply as a framework to the problem of DACC in chapter 1.

As such, Chapter 1 partially operates as an extended introduction. It sets up the theoretical background to the thesis by elucidating the role of economic conceptual and ethical frameworks in understanding both the problem of DACC and the three main criteria for an international agreement designed to resolve it. In particular, I critique the conventional economic description of DACC as a 'tragedy of the commons', a view implying that man-made climate change is an inevitable result of the common resource nature of the atmosphere. I argue, rather, that the "tragedy" results from an economic perspective which treats the ecosystems and other public goods as 'externalities'. I then consider an alternative, Green Economic approach to the problem, building on Herman Daly's reconceptualisation of the economy-ecosystem relationship that underlies much green economic thinking, and which pictures the economy and society as subsystems of ecosystems. I argue that the three criteria for a climate agreement - ecological effectiveness, equity and efficiency - emerge in this particular order from this conceptual approach. This ordering is not, however, a straightforward prioritisation, but what I have termed 'ethico-conceptual'; each is defined within the context of and in terms of the former, which are preconditions of the latter (If this appears somewhat abstract here, the reader will, I hope, be helped by the examination in

[16] I have chosen this term for clarity rather than "global warming" or "climate change", and because the "dangerous anthropogenic" prefix takes on board concerns that the move from "global warming" to "climate change" was a political attempt to sanitise the phenomenon (Poole, 2006).

section 2.2). It is within the context of this ordering that I consider interpretations of each of the criteria in the subsequent chapters.

Chapter 2 examines ecological effectiveness, the first of the ordered criteria, which defines the ecological emissions space within which the equity and efficiency criteria can be applied. I consider the standards by which a mitigation agreement is judged ecologically effective; how it should define global emissions limits in terms of the "danger" to be prevented in DACC. This divides into two main aspects, covered by parts A and B of the chapter. The first concerns the particular *outcomes* that should be prevented and possible justifications for their prevention. I argue that the relevant harms threatened by DACC are to the ecological conditions of functioning and flourishing of future generations and, more originally, that both anthropocentric and non-anthropocentric views will coincide on when these occur. I argue further that in seeking to prevent such harms, costs to current generations should not be taken into account through straightforward intergenerational burden or resource distribution, but in terms of how they transform our current societies and their ecological pre-conditions as they evolve into future forms. The second part of chapter 2 considers how we should respond to uncertainties over the emissions levels at which these outcomes occur. I argue for a particular interpretation of the precautionary principle which understands them *as* uncertainties rather than risks that can be straightforwardly absorbed into conventional cost-benefit calculations.

Chapter 3 examines the criterion of equity within the context of the limits defined by chapter 2. I examine four possible conceptions of equity[17] which could be used to determine an equitable distribution of emissions allowances between countries[18]. These are: Comparable Effort; Equal Allowances; Capacity and Basic Needs. I draw on philosophical literature on equality and distributive justice, which has only recently begun to be applied to the climate change debate[19]. I argue that whilst equal (per capita) allowances may seem an intuitively equitable principle, it does not allow for existing inequalities in wealth – and welfare- between

[17] As identified by Ashton and Wang, 2003

[18] I use the terms "non-industrialised"/ "industrialised" or "poorer"/"richer" countries throughout the thesis rather than "developing"/"developed", which I regard as somewhat patronising.

[19] E.g. by Page, 2008; Starkey, 2008

countries. I therefore argue in favour of a Capacity principle, understood from the perspective of equality of objective welfare. Although a 'Basic Needs' principle might also seem to offer a prioritarian alternative, I argue that it either collapses back into a principle of 'Capacity' and stricter egalitarianism, or fails to account for relative poverty. Elsewhere[20] I have argued that a fifth principle, 'Historical Responsibility' is only equitable in so far as it is contingently linked to Capacity.

Chapter 4 considers the final criterion: efficiency. I explain limitations in conventional economic definitions of efficiency which mean that it risks undermining or replacing both ecological effectiveness and equity. I consider an alternative approach implied by Herman Daly's understanding of allocative efficiency which views it as operating only within the limits of the first two criteria. I examine carbon trading as the paradigm case for this approach. However, drawing on critiques of carbon markets, I argue that this conception of efficiency still retains a narrow economic imperative which threatens nonetheless to work against the apparent limits of its operation and undermine ecological effectiveness and equity. I propose an alternative conception, drawn initially from Schumacher and Daly's general concept of efficiency, that defines efficiency directly in terms of ecological effectiveness and equity rather than acting as a competing value which requires restraint.

Suggesting that these criteria should be used to evaluate policy proposals might be said to be more idealistic than pragmatic. However, what is deemed pragmatically possible is largely grounded in the dominant political and economic ideologies of the day[21] . One's perception of the limitations on possibility will depend on which beliefs and practices are held as fundamental and which are susceptible to change. Human societies, unlike the physical world, are not guided by fixed laws - rather, reflection on them can alter their operation in turn[22].

[20] Makoff, 2011

[21] Whilst ultimately limited by some physical constraints e.g. to build renewable technologies , possibilities are largely dependent on political will - for example, if all resources were diverted to an effort on the scale of mobilisation during WWII, then achieving quicker, deeper structural changes could be more feasible (Simms, 2011)

[22] Daly and Cobb, 1990, p93, on how the economic model "influences actual behaviour away from community-regarding patterns towards selfish ones".

Hence Maurice Strong[23] has lamented how the economic rhetoric surrounding DACC reminded him "of the clamor surrounding earlier fundamental changes in the way business was done – that is the movements to abolish the slave trade and later child labor. Then, as well, the dominant economic ethos of the times clashed with a new moral and ethical responsibility". So, whilst there is an important role for some policy research to be based on the assumed constraints of current political limitations, there is also a vital role for thinking about policy in a way that tests and alters these limits, opening new possibilities[24].

Accordingly, this thesis attempts to set out a conception of the ideal standard towards which climate policy should be shifted, *as far as possible*[25]. But as others have argued[26], there is also a pragmatic reason for ethical debate on climate policy. In global climate negotiations still dominated by power clashes and short-term national interests, broader principles which can be mutually respected are needed to underpin and drive forward climate policy and foster agreement. The dialogue must be shifted towards finding ethically-guided common aims which define concrete policy and away from simply aggregating the minimal commitments which individual nations currently feel they are separately prepared to sacrifice[27]. The latter has continued to describe much of the negotiations at the recent climate talks in Cancun, 2010, where, as one WWF campaigner has described, "They say that they want 2C, the pledges don't get to 2C. It is like the emperor has no clothes"[28].

[23] Former under-secretary general of the U.N., cited in Brown, 2002, p239.

[24] This is somewhat analogous to Baker's interpretation of Wittgenstein, that the primary task of philosophising is to create new possibilities or awareness of alternative possibilities. That philosophers are in the grip of pictures and by recognising this are no longer constrained by them, but can entertain the possibilities of others (see Hutchinson and Read, 2008, section II).

[25] And, given what I have said about possibilities, the phrase "as far as possible" cannot be determined objectively and in advance but is created depending on how far people - politicians, economists, campaigners, government advisers and the wider public – can create and be influenced by them. See also chapter 2 section 4.4, where I discuss this further.

[26] E.g. Meyer, who argues that "equity is survival" (Meyer, 2000, p17) since equity is needed to gain support from low-income, low-emitting countries who will resent further reductions whilst richer countries' are still far higher. Baer et al argue similarly in Baer et al, 2008, p28.

[27] I.e. it must move from being a "political science problem", to "an ethical problem", Baer, 2002, p394-5.

[28] Lou Leonard, quoted by Black, 2010.

This is not to suggest that philosophical enquiry alone will resolve the global impasse or offer a mythical neutral path forward. But it can contribute arguments for defensible solutions, and offer conceptual and ethical tools to guide the content of debates. It can question the robustness and integrity of assertions that particular policy solutions are more justifiable than others. It can help formulate ethical criteria underlying such claims, draw out ethically relevant differences between policy proposals and strengthen or discredit grounds for the arguments of campaigners and policy advocates. And, as I argue in chapter 1, it can help to remove misconceptions, in particular, of conventional economics, which can blinker our collective vision away from more radical and very possible solutions.

The potential contribution of philosophy to climate change is therefore wider than might be supposed. The questions I consider move beyond the domain of conventional ethics and moral/political philosophy. They also demand reflection on our relationship with the wider ecosystem – how it is and how it should be – and, as I argue in chapter 1, on the constraints this places on human socio-economy, which have been transgressed in the case of DACC. This involves the relatively newer domain of environmental philosophy but additionally, perhaps less obviously, philosophy of science and of economics. Because such reflection involves challenging ontological assumptions about how our social, economic and ecosytemic environment are constituted, assumptions which frame different analyses of the causes of the threat of human-induced climate change, and which in turn influence the solutions proposed[29].

It is worth clarifying my methodology. Although I draw from particular conceptual and ethical approaches, including green economic philosophy and radical egalitarian positions, I do not claim to develop a theory of the problem of DACC or how it should be addressed: at least not in the sense in which theory is understood within science. This is partly because it does not seem meaningful to invoke theory for questions of human action, analogously to the use of theory in the physical sciences.[30] Here I roughly follow Winch, who considers that one cannot

[29] This in turn, reflects back on traditional moral/political philosophy. We should ask, as Daly has of economics, "What insights can we gain from traditional [morality]? What mistakes must we correct?". Daly, 1997, p61

[30] Where, i.e. analysis involves "methodological or substantive reductionism, Hutchinson et al, 2008, p3.

understand society or its operation as in scientific study by abstracting and generalising from it[31]. The objects of study are people, with meaningful, rule-governed behaviour[32]; "A man's social relations with his fellows are permeated with his ideas about reality"[33]. To understand a society, one therefore has to understand its particular ideas, such that "the understanding of a human society is closely connected with the activities of the philosopher."[34] . Read has expressed this more recently with regards to economics: "there *is* no 'just stating' the laws or facts of Economics. *Every* economic or political move, including the moving of stating the alleged facts or laws *affects* 'the' laws/facts... *the very 'laws' themselves are thoroughly reflexive and utterly historical*"[3536]. The point here is not that we cannot analyse and understand behaviour in social science; rather that the term 'theorising' does not appropriately describe the activity.

Likewise, the notion of ethical theory in morality is misleading. Ethical theories seek to capture and systematise our moral instincts about a situation. Rawls famously describes this using the idea of 'reflective equilibrium'[37], where an ethical theory attempts to provide an account (expressed through "regulative principles"[38]) of our moral instincts, which can in turn be altered to conform with the theory, and so on, until theory "matches" our judgements in "reflective equilibrium". But in this case, it therefore appears misleading to describe this process as one of moral 'theorising'. Because, as Rawls acknowledges but does not thereby find telling, moral instincts are not, as "with physics"[39] fixed like the initial data and observations from which we generalise, but are themselves altered and shaped by ethical reflection on possible "regulative principles".

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[31] Winch, 1990, p66-71
[32] Winch, 1990, p50
[33] Winch, 1990, p23
[34] Winch, 1990, p91
[35] Read 2007a, p318.
[36] Daly and Cobb offer a similar critique of the misleading abstractions of neo-classical economics and the "fallacy of misplaced concreteness" (Daly & Cobb, 1990, p35-43.). See chapter 1, section 2.2.
[37] Rawls, 1972, p48
[38] Rawls, 1972, p49
[39] Rawls, 1972, p49

Let me explain by considering this process of moral reflection in more detail. I understand 'moral instincts' as one's various beliefs about how to act in particular scenarios. These beliefs may or may not be consistent with one another, they can change over time after discussion or reflection that emphasise particular principles, and are themselves the result of previous reflection. For example, should Jim arrive at a lakeside to find the oft-mentioned drowning child, his moral instincts may plausibly[40] be to swim to save the child, and/or to encourage the child to save itself through shouting encouragement, thus 'empowering' it, and/or that the child should take responsibility for its own actions in unadvisedly swimming alone in a deep lake. Consideration of particular regulative principles may justify particular instincts over others, for example: 'if you have the ability to prevent death/suffering, you should do so" or "people should take responsibility for their own actions". Being torn between them, he may proceed to consider other similar situations in which each principle might be applied: do one's instincts here likewise suggest that the principle will be supported? For example, supposing he favours the latter principle. Considering a scenario where the child were his own, were much younger or had been coerced by others may lead to refinements of the principle, or its abandonment and possibly (I would hope, in this case) revision of his instincts in the initial scenario.

This process depends on appealing to particular scenarios where one's moral instincts are particularly strong or uncontentious and using these as analogies for others that are similarly structured, but more ambiguous. One's guiding regulative principles that are considered and employed in this process thereby depend on the features of these clearer cases, which become a model from which to operate. That is to say, alongside Lakoff and Johnson, that morality is ultimately "structured metaphorically", and moral 'theories' employ distinct conceptual metaphors[41] to refine our moral instincts in particular ways. Different moral metaphors can be employed in particular ethical cases, drawing out different kinds of features of the situation.

[40] Although this is not to suggest that I find all of these possible beliefs morally palatable or justifiable, they are merely examples of plausible moral feelings some people may have.

[41] Lakoff and Johnson , 1999, p290 (see chapter 14, "Morality"). I do not discuss the particular metaphors that they believe to constitute moral concepts but agree that "our moral understanding is thoroughly metaphoric" (p292).

For example, in the case of the drowning child above, one might varyingly conceptualise the relationship between the child and Jim as victim and rescuer, as student and teacher, or (albeit exceedingly harshly!) as miscreant and disciplinarian.

Not all may be argued to be appropriate or ultimately justifiable (as I expand on shortly), but they sometimes may be, depending on the particular circumstances[42], and can imply different actions either singly or in combination. To take an example from this thesis, I examine in chapter 2 section 2 how the "intergenerational equity" metaphor understands intergenerational obligations in terms of an equitable distribution between two spatially distinct groups, in contrast to a distinct, developmental metaphor, and consider how both metaphors should contribute to our obligations in reducing greenhouse gas emissions.

This is where the term 'theory' is misleading; it implies the possibility of a full and final moral description of human action and a set of principles which can and should be turned to in advance of any particular case. My concern here is similar to Graham Smith's criticism of the "ethical monism" prevalent in mainstream moral philosophy, that "Within both the broader field of moral philosophy and environmental ethics itself, the defence and refutation of competing systematic theories is one of the principal preoccupations, carried out in the belief that we will eventually discover irrefutable arguments in favour of one particular theoretical approach, whether Kantian, utilitarian, neo-Aristotelian or whatever... Much time is spent by proponents refining theories to account for particularly obscure possibilities and to create an ethical theory which can deal with all potential situations.".[43] Whilst some writers do seem to distance themselves from such a picture, and acknowledge the limits of ethical theorising and

[42] For example, whilst I imagine few in the case above would hold moral instincts to ignore the child and teach it a lesson, but suppose the child is not drowning but has armbands and is simply stuck in the middle of the lake – wet and miserable but not at risk of long-term physical harm. Perhaps the child does this on a regular basis, is at constant risk to himself and will continue to do so unless he has the opportunity to experience the consequences of his actions.

[43] Smith, 2003, p19. Desjardins hints at a similar kind of scepticism about the role of moral theory "as providing the same general type of practical guidance as science and technology". Whilst, he argues, "many philosophers... believe that the role of ethics is to provide a general principle or theory that can be applied in specific cases and from which we can deduce specific practical conclusions" and that "ethics is capable of offering the same kind of objective and unambiguous conclusions as science.", he warns that "Ethical issues of any type... are seldom open to such unambiguous resolution. The world is not as simple as we might like it to be." (Desjardins, 2006, p14).

the ultimate ambiguity in concrete ethical issues, they often still understand themselves as engaged in the process of theorising, and consider and evaluate moral theories *as* competing theories[44]. I suggest that such "ethical monism" ignores those metaphors emphasised in other ethical 'theories' and the moral dimensions of a situation that they highlight, which may also sometimes be relevant and justifiable.

Similarly Lakoff & Johnson argue that "The traditional view of moral concepts and reasoning is predicated on denying that our moral concepts are metaphoric", but "we do not, and cannot, have... some metaphor-free way of conceptualizing abstract moral concepts or entire moral positions... we do not have a monolithic, homogeneous, consistent set of moral concepts"[45]. My understanding of morality as metaphorical is different, therefore, from (for example) the Kantian view of morality along foundationalist lines. For Kant, one can rationally derive a universal moral law, the Categorical Imperative, and further moral rules from its various formulations to regulate one's behaviour. These are universal not just in the sense of applying to any and every rational agent, but also in the sense of duties that govern any and every situation. This paints rationality as a neutral form of argument, embodying metaphors of law to conceptualise "laws of freedom"[46] and "duty" as a motive distinct from "inclination"[47].

However, I should not be taken merely as arguing for pluralism per se, if, as Wenz implies, it is conceived as offering some form of "pluralistic theory"[48], or the acceptance of multiple monistic "theories"[49]. Rather, I am advocating what might be called an 'open pluralism'[50], in that none of these 'theories' can be understood as self-enclosed systems that wholly capture moral phenomena, in the way they normally strive for. Metaphors from different 'theories' can

[44] For example, Jamieson reminds us that "All... theories have strengths and weaknesses, and at some point all of them exact a price that some people are not willing to pay. Rather than viewing them as finished objects that should be either worshiped or condemned, these families of theories should be seen as ongoing research projects.". But this still implies the possibility of ultimate success that was criticised by Smith.
[45] Lakoff and Johnson, 1999, p330
[46] Kant, 1993, p53
[47] Kant, 1993, p64
[48] Wenz, 1993, p62 and p69.
[49] Ibid., p65
[50] Thanks to Tom Greaves for this suggested terminology

be combined and contrasted in the process of moral reflection on different kinds of scenarios to give new and unexpected insights.

This is not to suggest that any metaphor may be appropriate or valid in every situation[51], or to take a morally relativist stance. We can still argue in each case for/against particular metaphors as better or worse ways of morally framing a scenario. This is not to match them to real-world moral 'facts', since truth and falsity are not the particular determinants of morality (although they may play a role in components of ethical disagreements, e.g. misrepresentation of scientific understanding on climate change which can and should be challenged). Rather, some may be unjustifiable because they are e.g. uncaring (such as the intergenerational equity metaphor[52]), too crude (such as game theoretical analysis of commons tragedies[53]), or, self-contradictory (tradeable permits as a model of 'embedded' efficiency[54])[55].

Yet neither is this to suggest that we should act purely instinctively and unreflectively, or that we should not consider and employ particular ethical principles to guide actions. We can and should. But these are not abstracted, law-like generalisations; one has to decide which apply in particular cases. One cannot avoid the case-by-case nature of ethical thinking, and which principles apply will depend on which metaphors are employed in morally describing the features of that case. What is typically understood as moral 'theorising' should be recognised as developing and considering the applicability of particular moral metaphors for different scenarios. And, the role of such moral 'theory/ies' in particular, concrete cases - such as, here, for DACC and the three criteria for climate mitigation policy – is to examine how far different moral metaphors and models from purported ethical theories compare to/ are appropriate to that concrete case. How far, that is, they frame the issues of the case in useful ways: whether they share any relevant moral features, whether they ignore others (which might be highlighted by distinct metaphors) or whether they are consistent. I use these not to form the

[51] After all, many metaphors conflict (see e.g. Lakoff and Johnson, 1999, p330).
[52] Chapter 2, section 2.3
[53] Chapter 1, section 2
[54] Chapter 4, section 2.2.
[55] See Bernstein, 1983 who explores how we can move beyond the "Cartesian Anxiety" that underlies the objectivist/relativist dilemma through reconceiving it as primarily a practical question (p222).

basis of a new theory (since this I hold this to be a misleading endeavour), but to reflect on and criticise various existing positions, values and principles, and develop others, to advocate an interpretation of the three criteria which I think is justified.

In arguing for the appropriateness of particular moral metaphors to this or any case, there will be disagreement. I want to emphasise again that this does not imply that all views on the matter are equally valid: I hold and believe that the approaches I advocate in this thesis are, roughly, how the matter of DACC *should* be understood and acted on, and that the actions of others should conform to this. Of course, those taking opposing views will disagree, and accordingly, will not perceive the approach and principles that I am advocating as applying to their actions (and vice versa). There is nothing neutral or external to these positions to which I can point to ultimately confirm my own position, or they to theirs. But this does not mean that both views are equally appropriate: we can seek to persuade each other through dialogue; perhaps I might try to relate my arguments to beliefs we hold in common, or draw attention to implications of their approach which they would reject in a similar case. This may or may not be successful, but this is the only route available, and so is the one I pursue here.

Lastly, some caveats on scope. First, I 'assume' in this thesis both that climate science is correct about the phenomenon of DACC[56], and that the problem needs to be tackled through mitigation[57]. Secondly, the thesis focuses almost exclusively on policy for climate mitigation, that is, the reduction of emissions levels so as to prevent some degree of DACC, rather than adaptation to the effects of DACC. Both are unfortunately now necessary[58] and are also inter-related since decisions as to mitigation efforts may affect adaptation measures and vice versa[59]. In addition, there are many other complex and important aspects of both mitigation

[56] I.e. that anthropogenic greenhouse gas emissions can alter and are altering climatic systems. See also appendix 2, section 1 on "theoretical uncertainty".

[57] I.e. that the changes to climatic systems are significant and will, at some level, cause harms (although these need to be defined), though see chapter 2, part B, section 3.1, for why it is inappropriate to require certainty before taking action

[58] We are already committed to some DACC and are already experiencing its effects – see chapter 2, part A.

[59] This may include, for example, the amount of money spent on each or the kinds of measures taken to tackle them, which may or may not complement one another.

and adaptation joint action which I do not explicitly discuss here, such as technology transfer, the creation and control of a climate finance fund and how to account for and reduce deforestation and maintain other atmospheric sinks which will affect the impact of emissions levels[60]. However, some focus is necessary to do justice to the questions being considered. So for simplicity I concentrate on criteria for the reduction of overall emissions levels and their distribution between countries. I envisage that the discussions could be somewhat similarly applicable to those other issues, but would need careful and separate consideration. I also consider policy at an international rather than national or community level, although all are vital in moving away from a fossil-fuel based economy and society[61]. Finally, there are of course ethical and political concerns other than the three main criteria discussed here which may also be relevant to international policy on climate mitigation. These include concerns of national sovereignty, liberty, flexibility[62] and participation and compliance[63]. Although I touch on some other issues, e.g. political feasibility[64], I have chosen to focus on the three dominant criteria in climate policy debates which have alone generated sufficient controversy but received inadequate attention.

Science alone is insufficient to deal with these questions: philosophy needs to broaden its engagement in DACC, to help guide us, alongside other disciplines, through the climate crisis and the controversies that emerge along the way. This thesis contributes much-needed work to this task, by tackling some of the central principles – and the connections between them - around global mitigation policy in a thorough and unified way, for the first time.

[60] E.g. the "REDD" (Reducing Emissions from Deforestation and Forest Degradation) proposals. See Lang, 2009.

[61] An international agreement is needed to provide the legal framework for coordinating global efforts and ensuring all countries participate: otherwise reductions in one country may be undermined by increases in others. But national and local action is equally necessary to produce the cultural, community and structural transformations needed to make deep emissions reductions, so that changes are locally appropriate and involve all sections of society.

[62] Aldy et al, 2003

[63] Ibid.

[64] See chapter 2, part A, 2.4, and see Kraus, 2009 who considers political acceptability and feasibility as criteria

Chapter 1 - Three criteria for an agreement – conflicts and priorities.

A: Introduction

0.1 Introduction to the three criteria

Since the IPCC's first assessment report in 1990 which formally identified that human-induced climate change posed a significant global threat, there has been ongoing political and academic debate as to how an international mitigation agreement should tackle it. The 1992 UNFCC treaty[1] provided the broad guidelines for countries to collectively limit and reduce greenhouse gases (GHGs) so as to "prevent dangerous anthropogenic interference with the climate system"[2]. But only the 1997 Kyoto Protocol provided for binding emissions reductions, and this has been widely criticised[3], was never signed by the one of the world's largest emitters, the United States, and expires in 2012. In the fierce debates over the past two decades over formulating both this initial Kyoto agreement as well as its successor, a wide range of policy proposals have been mooted[4]. Writers have attempted to justify, compare and evaluate these proposals using a variety of principles, but have increasingly focused on three particular criteria. These are that the agreement should be (a) environmentally or ecologically effective[5], that it should be (b) efficient and that it should be (c) equitable[6]. Whilst these are not the only ones to be described as necessary[7], they are the most commonplace to be applied in various combinations[8] and roughly reflect the three goals of sustainability literature[9].

[1] The treaty came into force in 1994.
[2] UNFCC, 1994, Article 2.
[3] Criticisms include: the exclusion of developing countries from binding targets (Soroos, 1998, p33); the flexibility mechanisms (See e.g. Brown 2002, p190-200; Lohmann, 2008a, 2008b & 2009); allowing carbon sinks to count towards targets (Gardiner, 2004, p25); the inadequacy of the reductions it aims for and pessimism over their being met (Gardiner, 2004, p34-36).
[4] See e.g. Kuik et al, 2008; Aldy et al, 2003, or Baer & Athanasiou, 2007 for an overview.
[5] See below for the distinction.
[6] I use letters for the time being so as not at this point to imply any particular ordering or priority, which will be discussed shortly.
[7] Aldy et al, 2003, use: environmental outcome, dynamic efficiency, cost-effectiveness, equity, flexibility in the presence of new information and participation and compliance.
[8] Stern, 2008, uses effectiveness, efficiency and equity; Agarwal, 2002, p386, requires three criteria, "ecological effectiveness", "economic effectiveness", and "socially just and equitable" policy solutions. Much debate focuses on the "efficiency-equity trade-off", e.g. Shukla, 2005.
[9] E.g. Edwards, 2005, p20

These criteria are vital to navigate between competing proposals and particular interests and move towards a justifiable global policy on DACC; but since there is little explicit debate on how each of the criteria should be interpreted, they can be stretched so widely as to lose their normative force. For this reason, I argue for particular interpretations of each in chapters 2-4. Equally important, however, is the priority of the criteria, since, in the event of a conflict between them, this could have significantly different policy implications. Establishing such an ordering is, therefore, the purpose of this chapter.

First, however, the criteria can be loosely outlined for the purposes of the current discussion. Environmental or ecological effectiveness can generally refer to the effectiveness of an agreement in lowering anthropogenic emissions to prevent "dangerous anthropogenic interference in the climate"[10]. In policy terms, its formulation will largely affect the size of emissions reductions, yearly global emissions trajectory or budget that is decided on. For example, interpretations may vary over the degree of effectiveness required (e.g. what global temperature rise should be prevented), how this is justified (whether through particular impacts on human societies or non-human considerations)[11] as well as how risk and uncertainty should be accounted for, since particular policies for emissions trajectories cannot guarantee any particular temperature rise[12]. I henceforth describe the criterion as "ecological" rather than "environmental" effectiveness, because, as argued in Part C of this chapter (and summarised in section 0.3 below), the Green Economic perspective that I adopt is built on a recognition of the rest of nature as 'ecosystem(s)' that human society is a part of, rather than an 'environment' that is outside of or beyond us[13]

Efficiency tends to refer to economic efficiency; either pareto-efficiency, or, more generally, minimising the costs / maximising the cost-effectiveness of climate policy[14]. As I discuss in chapter 4, this could mean minimising the costs of achieving particular emissions reductions, or minimising overall costs of climate policy (i.e. also determining emission reduction levels). Which is held depends in part on whether efficiency is seen as a

[10] UNFCC, 1994, Article 2.
[11] See chapter 2 part A
[12] See chapter 2, part B.
[13] That is: Green Economics embraces "ecologism" rather than "environmentalism", outlined by Dobson, 2002, p2.
[14] Although this latter is not always what is meant by "economic efficiency" within the discipline of economics, it has been understood in this way by many climate policy writers as I explain in chapter 4.

substitute for ecological effectiveness, as I discuss in chapter 4, sections 1.2 and 2.1. I suggest a further, preferable approach to efficiency in chapter 4, but for now assume roughly the conventional understanding.

The equity criterion seeks to ensure the distribution of the burdens from mitigation[15] is equitable, between (or within) countries. This is often understood in relation to the UNFCC guidance that climate change policy should be "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities"[16], i.e. taking into account countries' different circumstances, although which are relevant here (and how) is subject to debate (see chapter 3). In policy terms, this relates to the distribution of emissions entitlements or reductions for each country, and/or the costs of mitigative effort. Equity can on occasion refer to inter-generational equity, but I have chosen to consider this within the realm of Ecological Effectiveness since it constitutes a means of judging the effectiveness of an agreement (i.e. the impacts of different climate change policies on future generations) and restrict the equity criterion to the intra-generational domain.

As suggested, these criteria can conflict with one another, depending on their interpretation. Policy proposals invariably meet each criterion to different degrees, and there is frequently understood to be a policy 'trade-off' between two or more of them[17]. However, there is very little rigorous consideration of how to approach such cases; how, that is, the criteria should be explicitly ordered or prioritised. Yet without committing to this, these criteria will be a blunt instrument for guiding climate policy, since a wide range of alternatives will seem equally justifiable. One of the clearest, (though somewhat simplistic) examples is of the (major) difference between international carbon tax compared to tradable rationed permits, 'cap and trade'. Both aim to provide emissions reductions as well as economic efficiency in terms of minimising cost. However, as is well noted in the literature, they differ in how far they succeed in meeting these criteria. An international carbon tax controls price by taxing carbon dioxide (CO_2) emitting activities, giving firms more predictability for their investments, but without guaranteeing what emissions reductions will be achieved. For this depends on the behaviour of firms and individuals in responding to the price rises. A 'cap and trade' system, by contrast, controls

[15] And/or adaptation, but I do not consider this here.
[16] UNFCC, 1994, Article 3.
[17] E.g. Aldy et al, 2003, p394

the amount of CO_2 emitted since global emissions are 'capped' and divided into permits which are distributed amongst countries, firms, or individuals, and can then be traded. But here, the price cannot be predicted exactly, since it depends, amongst other things, on the behaviour of permit holders – how many want to sell or buy extra permits. This risks costs being significantly higher.

As Goulder and Nadreau have suggested more explicitly, in this example we are faced with two alternative uncertainties – of quantity of emissions under an international carbon tax, or price under cap and trade. "Which uncertainty is worse?" they ask, concluding, "There is no easy answer"[18]. However, an answer can be given if we are clear about how we order the criteria and our justifications for doing so.

0.2 Aubrey Meyer's "prioritized" priorities.

The only attempt at such an ordering apparently made to date is by Aubrey Meyer, founder of the "Contraction and Convergence" (C & C) proposal. C & C was one of the first major policy proposals aiming to offer an ethically sound international approach to mitigating climate change. In common with many other broadly ethical analyses of climate change as an international challenge, it supposed a criterion of equity, but tried to place this within the context of other criteria (referred to as "priorities"), which, ordered according to importance, should ground an agreement on climate change. These were 1) Precaution, 2) Equity and 3) Efficiency, which, if followed, are supposed to give rise to 4) - "ten thousand things"[19]. However, 1 to 3 are all that are significant for our purposes for the time being, since 4 largely signifies that "sustainable prosperity"[20] can only be reached by adhering to criteria 1 to 3 in that order[21].

These roughly correlate to the three main evaluative criteria I have been describing, except that "precaution" refers to a narrower aspect of ecological effectiveness[22]. It assumes that

[18] Goulder and Nadreau, 2002, p134
[19] Meyer, 2000, p33
[20] Ibid.
[21] 4 could therefore be seen as the value basis underlying the order of 1-3 for Meyer– i.e. the (broadly anthropocentric) furthering of human prosperity, although, as I argue in appendix 2, there seems very little difference in practice between ecologically anthropocentric and ecocentric positions on DACC.
[22] See chapter 2, introduction.

we are already clear about what constitutes "danger" in terms of climatic change[23]. Whilst for Meyer 'precaution' performs largely the same function as 'ecological effectiveness' in my own analysis (i.e. requiring limits on total GHG emissions), I retain "ecological effectiveness" because "precaution" is, I think, too narrow[24]. For example, 'precaution' can be misleadingly applied to suggest taking a precautionary approach to our economic system and not taking the 'risk' of reducing emissions, rather than to imply a precautionary approach to climatic systems, as Meyer intends it. We need to more explicitly defend why the danger to climatic systems should take ethical priority, and 'precaution' alone does not express this.

However, to set this aside for the moment, if "ecological effectiveness" is substituted for "precaution", we can see how something like Meyer's ordering can guide (or justify) policy and allow us to choose in an apparent trade-off. Because in the example above, these ordered criteria would imply that 'cap and trade' is preferable to an international carbon tax, since it gives more certainty over emission levels than prices, reflecting the precedence of Ecological Effectiveness over Efficiency[25]. By considering the way the three criteria should be ordered and the relationship between them, we can clarify the reasons for preferring particular climate policy proposals, and their respective ethical merits[26]. This helps provide a more transparent basis for comparing policy proposals, making more explicit the ethical dimensions of the debate so a more fully informed discussion – and solution - can be attained.

0.3 Grounding the order of the criteria.

This requires being clear about the economic value framework that underlies and justifies an ordering of the criteria. This is not just an ethical framework. For, as in parallel

[23] "... the precautionary principle focuses on the need for a spatially unified global purpose across time and space to avoid danger which is the Convention's 'objective' (prevention by contraction)…", Meyer, 2000, p33

[24] Although, as I argue in chapter 2, part B, precaution is an essential component of the ecological effectiveness criterion.

[25] It is evident that writers do make such choices implicitly in preferring one or the other, but in doing so they do not often talk explicitly about ordering these criteria. Rather, they may focus one or more of them, claiming for example, that only their proposal meets the demands of equity, or of efficiency/ cost-effectiveness.

[26] To be clear; I am not suggesting that the criteria are themselves necessarily values, since they cover a range of different possible values (for example, ecological effectiveness might involve valuing the environment either instrumentally and/or intrinsically). The point is that how we order the criteria does express some particular value choices and ethical priorities.

discussions in sustainability literature[27], our ordering and understanding of the three criteria also reflect our economic conceptualisation of the world, and in particular, the way in which we understand the relationship between three conceptual 'spheres' of human economic interaction – the economy, (human) society and the environment. This is because these criteria can be understood as mapping onto (though not exhausting[28]) these spheres in the following way: Ecological Effectiveness as a guide or limit to economic interaction with respect to the environment, Equity as a social guide to economic relations between humans, and Efficiency (as conventionally understood) as an economic imperative for the functioning of the economy itself[29].

But in addition to the conceptual aspect of this value framework there is inevitably an important ethical dimension. For any ordering of the criteria also embodies value judgements made in the context of a particular conceptual economic picture. Otherwise they would hold no normative moral force and constitute description alone. Any ordering of the criteria and the economic value framework that underlies it is, in this way, what I shall term 'ethico-conceptual'. I discuss this, and the conceptual and ethical dimensions more fully in part C of this chapter.

In parts B and C that follow I want to look at two such opposing economic value frameworks which imply two very different ways of ordering and understanding the criteria. But 'economic' here does not imply simply alternative economic systems, tools or brands, but alternative political economics; alternative ways to understand economics in context of society and the environment – two "*eco*-political-economies". The first is what I consider to be the conventional economic paradigm[30], largely based around the neo-classical economic model (but which also has variants in environmental economics, which I consider in part B). Here, the economic sphere is potentially infinitely expandable in relation to society and the environment; both in terms of economic reductionism whereby social and environmental concerns can be fully captured by narrow economic calculations,

[27] E.g. Edwards, 2005, p21-23

[28] They are not exhaustive in part because of scope; equity, for example, does not exhaust the scope of social concerns.

[29] The phrasing "economic imperative for the functioning of the economy itself", from a conventional economic perspective implies norms internal to the economy. But by the end of the chapter 4 (and consideration of green economic efficiency) "the economy itself" (and "economic imperative") does not just imply an entirely separate domain with distinct norms, but an activity as necessarily nested within the society and ecosystem, and with guiding norms only understandable in relation to them.

[30] In the west/affluent north at least in the last century, and in the past few decades in the globalised south.

and physically, in terms of the growth of the economy. These can be represented by three distinct but overlapping spheres (where, that is, the latter are represented at all, see discussion in part C section 2.1). The successful functioning of the social and environmental spheres can, under this view, be increasingly understood in terms of what are taken to be the internal concerns of the human economy – an economy constituted by market mechanisms mediating between and optimising across competing rationally self-interested human preferences . The kinds of climate change policies that result, as I will argue in part B, implicitly prioritise Efficiency over Ecological Effectiveness and Equity. Yet under this perspective there is not necessarily any conflict between the criteria; for those adhering to this picture-driven analysis, the latter two can be understood and justified in terms of the former.

The second approach is an alternative that has emerged from criticism of the conventional paradigm and an awareness of it *as* a characterisable and particular conception of eco-political economy, as opposed to representing an allegedly value-neutral approach as is often presented[31]. This alternative is "Green Economics" (explored in part C), which understands the economy as embedded within both society and the environment (or rather, the ecosystem); as a subset of it, and, properly, subservient to the ends of both environmental protection and the fulfilment of human needs and social well-being[32]. Both ends are, however, as I argue in section B, failed by the current economic system in part because the paradigm underlying it does not recognise this embeddedness and never allows their qualitatively distinct and long-term dimensions to be fully reflected in its quantitatively based decision making process which prioritises narrow, short-term economic value.

Instead, Green Economics requires that these social and ecological ends should be directly assured through non-market mechanisms such as regulation, taxation and institutional structures, though for most Green Economists the market and other conventional economic tools may still have some role to play as well. For its advocates, Green Economics is the culmination of mounting tensions both within the economic discipline (manifested through

[31] Reardon, in a survey of 17 US economic principles textbooks, has highlighted how "mainstream economics" encourages "students to think in terms of deductive logic, partial equilibrium analysis and marginal cost/benefit analysis" which are "presented as 'value-free'". Reardon, 2007, p383.
[32] See Scott-Cato, 2009, chapter 11.

critiques from heterodox economics[33]) and between core economic assumptions and evidence from in particular environmental and ecological science on, for example, the physical limits to economic growth. Whether or not we are in fact on the brink of a paradigm shift in the Kuhnian sense[34] will be judged by future generations, but for Green Economists this is the kind of process required in order to shift to a more appropriate economic way of conceptualising the world and managing our economic activity, from one whose tensions can no longer be reconciled.

A Green Economic perspective implies, I will argue, an ordering of the criteria similar to that proposed by Aubrey Meyer, with Ecological Effectiveness first, Equity second and Efficiency third. This will be explained in part C, along with further consideration of how we should understand this ordering as above and beyond simple "prioritisation". However, it should be emphasised that the Green Economic positioning of Ecological Effectiveness as the first criterion need not imply an ecocentric conception of environmental value, nor, similarly that the difference between the green economic and conventional economic perspectives can be straightforwardly construed according to the intrinsic/instrumental divide. Green Economics can also be understood as advocating ecological effectiveness for anthropocentric (strong as well as weak forms[35]) reasons, as I examine in appendix 1.

0.4 Theoretical Clarifications.

Both positions in this analysis function to represent distinct theoretical approaches – groupings of positions at either end of a spectrum regarding the eco-political economic picture they adhere to and advocate. This is not, then, to ignore other heterodox economic approaches and political economies which have critiqued the neo-classical ideology prior to green economics (e.g. Marxian, Institutional, Feminist economics, a tradition which is acknowledged by green economists[36]). Neither does this deny the significant theoretical divisions within both approaches in terms of position along the spectrum as well as

[33] Kennet & Heinemann, 2006; Scott-Cato, 2009, p8;
[34] I.e. historical, where in Kuhn, 1996, the paradigm ("accepted examples of scientific [in this case economic] practice" that "provide models from which spring particular coherent traditions of scientific [economic] research" (p10)) suffers from increasing tensions with observation and experience – a "failure of existing rules"(p68) - creating anomalies which cannot be accommodated into the paradigm (p52), resulting in crisis (p76) which, if not dissolved, can "end with the emergence of a new candidate for paradigm and with the ensuing battle over its acceptance" (p84).
[35] See Dobson, 2000, p51 on the distinction between weak and strong anthropocentrism
[36] See Kennet & Heinemann, 2006 for a thorough examination of the intellectual economic heritage of Green Economics

regarding other dimensions (such as values like liberty and autonomy), which are not being considered here. Rather, the purpose of defining the two ends of this spectrum is to emphasise a particular divide in the way that relations between the economic, social and ecosystemic spheres can be conceptualised and valued which is especially relevant for climate change policy. It is to draw out how our basic picture of these relationships, our "pre-analytic vision"[37], affects how we conceptualise and analyse the problem of anthropogenic climate change and the criteria by which we judge the solution.

This forms the basis from which I argue in favour of a Green Economic position and the corresponding ordering of the criteria which it would imply. I make this argument from the point of view of someone whose own 'pre-analytic' perspective lies within a Green Economic approach. But I do not see this as problematic since a neutral position outside either approach is not attainable. The two perspectives should not be regarded as theoretical lenses that can be removed to reveal a neutral or truer state of affairs – rather they should be understood as paradigmatic world views[38], more comparable to perception itself, without which no conception can be formed of ontological entities – economy, society, ecosystems or associated values in the first place.

The form of the argument through sections B and C is, therefore, to argue from a Green Economic perspective that the conventional economic paradigm does not form an ethically appropriate or conceptually tenable model for analysing the problem of anthropogenic climate change or for its corresponding ordering of the three criteria for an international mitigation agreement. I proceed through examining how each perspective treats climate change as a "global commons" problem and their underlying assumptions and value judgements.

[37] Daly and Townsend ,1993, p 5, building on Schumpeter's tern.
[38] Although, as I clarify in Part C section 1, not wholly in the Kuhnian, strictly scientific sense; paradigms for social analysis operate differently.

B. The tragedy of the commons or the tragedy of economics? "Efficiency first" & neo-classical economic approaches to climate change.

1. The tendency towards overexploitation: public goods and common goods.

In this part of the chapter I look more closely at the neo-classical economic approach to the problem of DACC and highlight significant difficulties with the kind of explanation it offers. These relate to its analysis of common or public good problems. As I explain in section 1, the overemission of GHGs that constitutes DACC can be understood in terms of failure to protect either a global public or a common good.[39] This good can be described, roughly speaking, as the atmosphere's capacity to absorb GHG emissions without destabilising the earth's climate regulation system. Diagnoses of the cause of this failure, however, can vary enormously, and lead to the prescription of very different solutions.

Conventional neo-classical economic analysis employs game theoretical assumptions about human economic relationships to locate the cause of this failure in an inherent tendency of common or public goods towards overexploitation. But this is based, as others have shown[40], on flawed value and conceptual judgements: an individualistic treatment of common goods which assumes that features of a market-based mode of interaction are features of human society. Whilst this may then be used to argue for possible solutions in either privatisation or state control of the commons in question, it can at worst be used to show that global co-operation on climate change policy will never be reached (see section 2.1), and at best, limits our capacity to respond by making particular policy (i.e. market-based) pathways seem inevitable(see 2.2). Such market-based policy solutions, I will argue, promote the criterion of economic efficiency at the expense of both equity and ecological effectiveness(see section 3). For they omit more egalitarian ways of making the transition to low-carbon societies, as well as obscuring other features of the economic system that have contributed to our current precarious situation. In this way, I conclude, DACC and the failure to tackle it arises not from the structure of the global climate commons itself but from the conventional economic approach, its concrete policies and game theoretical view of the world that dominate decision-making.

[39] Depending on whether it is thought of as rivalrous or non-rivalrous; more on this shortly.
[40] E.g. Ostrom, 1999; Buck, 1998 (see section 2.2).

First, however, I shall explain how the atmosphere's climate regulating function can be considered as either a public or common good. This is a standard distinction made within economics between two different kinds of shared, or non-excludable goods. Public goods are defined as being non-rivalrous in that one individual's 'use' of the good does not detract from another's 'use'. Classic examples include street lights, security or clean air. Common goods, or commons, however, are defined as rivalrous, in that one individual's use of it reduces or detracts from another's ability to use it. Examples include fisheries, forests and other limited resources, limited either in absolute quantity or regenerative rate. Both descriptions are used in climate policy literature, but emphasise different features of the climate change problem.

There is a clear sense in which aspects of the emergence and continuation of DACC can be construed as public good problems, and the atmosphere as a public good. Firstly, in so far as we consider the atmosphere's use for us as a sink for GHG emissions, it seems non-rivalrous. My emission of GHGs does not in itself (without limiting overall emissions) affect your ability to emit. Secondly, the sense in which we understand the overexploitation of this function of the atmosphere is in terms of its climate regulation role, and the associated stability of ecosystems and natural cycles (e.g. carbon, water and so on) which we depend on for survival. This ecological 'use' to us of the atmosphere; regulation of climate, seems also non-rivalrous, in that my receiving the benefits of a stable climate, will not subtract from your doing the same. Both 'uses' of the atmosphere could be said to constitute public goods, although the second is that normally emphasised as threatened in DACC, and the first use as the means by which the second is either preserved or exploited. Indeed, this is the way in which the problem is understood by Lord Stern, as I will highlight shortly.

In what sense, then, can the atmosphere be considered a commons if both relevant "uses" described above are non-rivalrous? Clearly, once a global emissions cap has been set, the first use becomes rivalrous – any emissions made from country A will detract from the 'space' available for country B to emit; a zero-sum game. But a commons reading is also frequently used to explain the development of the problem of DACC itself, as a case of a 'tragedy of the commons'. This draws on Garrett Hardin's now classic scenario to represent what he viewed as the inevitable deterioration of common lands, shared by villagers to graze cattle in Britain prior to enclosure in the eighteenth century. In Hardin's

analysis, a village commons has a certain "carrying capacity" of cattle, beyond which it would be damaged, overgrazed, and no longer be able to support so well the cattle that used it[41]. He argued that where there is free access to the commons, each herdsman, wanting to maximise their personal benefit from the land, would always want "to add another animal to his herd"[42], since the utility gained from an additional animal to sell is greater to each herdsman than the (shared) costs from overgrazing and reduced effectiveness of the land. The "commons" scenario is a tragedy for Hardin because "ruin" is inevitable in any situation where there is "Freedom in a commons" and people are acting rationally, i.e. "each pursuing his own best interest"[43] (often described as a "Prisoner's Dilemma involving a common resource"[44]).

How does this apply to the emergence of DACC? In the Hardinian commons example the costs of overexploitation are felt through the deterioration in quality of each unit of use – past a certain point (the carrying capacity of the land), each additional sheep will cause all sheep to be less well fed. This is the "rivalrous" element. But in the case of the atmosphere as a potential global commons, the effects of exceeding carrying capacity are felt in (indeed carrying capacity itself is defined in terms of) the second, ecological 'use of' the atmosphere as a climate regulator, rather than in a deterioration of its use as a dump for emissions that caused the overexploitation[45].

A commons-based reading of DACC, then, must recognise the relationship between the two senses in which we have benefited from the atmosphere's absorption of GHGs; that increased use in the first sense subtracts from and deteriorates use in the second sense. This means the atmosphere's use as an emissions dump is understood as limited, even before any kind of cap is in fact implemented. Recognition of the carrying capacity of the atmosphere, implies a zero-sum game, in which its use as a sink is rivalrous.

The "tragedy of the commons" scenario can, therefore, be used to explain the continued overexploitation of the atmosphere's absorptive capacity for GHGs as a *global* commons. The Hardinian analysis is imported to explain the continued degradation of the global

[41] Hardin, 1968, p1244
[42] Ibid.
[43] Ibid.
[44] Gardiner, 2006, p400.
[45] I.e. people are affected in other ways: it does not (directly) make the act of emitting less financially rewarding.

atmospheric commons[46] through rising emissions. This can crudely be seen as a result of rationally self-interested actions of emitting actors – individuals, businesses and other groups – but in particular nations, since a "global commons" can be "loosely defined as a domain that is beyond the exclusive jurisdiction of any one nation but one that all nations may use for their own purposes"[47]. Each nation operates analogously to Hardin's villagers, acting only in consideration of the private costs and benefits of emitting activities until the carrying capacity of the atmosphere has been breached. With free access to this capacity, (non-excludability), the model says, even knowing the danger, each actor will 'rationally' carry on GHG emitting activity, because the benefits to them from the cheap energy of fossil fuels outweigh the costs from this additional unit of emissions – because these are costs that are shared globally, by many more people, now and in the future[48].

The public good reading of DACC describes the same kind of phenomenon. Both commons and public goods are, within the current economic paradigm, analysed in a similar way and supposedly subject to the same inherent tendency towards overexploitation. Whilst a commons risks deteriorating because each actor seeks to maximise their individual benefit by continued use despite the shared costs that arise as a result, a public good can suffer from the analogous problem of free riding. A public good deteriorates for conventional economists either when its protection is ignored altogether in economic decision making (it is treated as a 'negative externality'), or, when its protection is agreed on but each individual privately benefits from not contributing its maintenance and attempts to free ride on the contributions of others. This kind of analysis is made, for example, by Stern[49] and by Grasso[50]. DACC arises from "market failure" since the "full costs of greenhouse gas emissions, in terms of climate changes, are not immediately… borne by the emitter, so they face little or no economic incentive to reduce emissions. In this sense, human-induced climate change is an externality, one that is not 'corrected' through any institution or market, unless policy intervenes"[51]. Whilst this is "market failure on the greatest scale the world has seen"[52], it does not imply a problem with the market

[46] See Soroos, 1998, p7; Rowe, 2005, p56. NB I suggest that the term "atmospheric commons" should be seen as shorthand for the climate system as a whole as it interacts with the atmosphere, including sinks – the earth's capacity to absorb GHG emissions from the atmosphere.
[47] Soroos, 1998, p7.
[48] See e.g. Gardiner, 2006, p402.
[49] Stern, 2006, p25.
[50] Grasso, 2004.
[51] Stern, 2006, p24.
[52] Stern, 2006, p25.

itself, but with its incomplete accommodation of costs to direct the economic decision-making; without being tweaked in the right way, the economic self-interest of emitting actors will inevitably lead to climate exploitation.

So conventional economics reads both commons and public goods as facing analogous tendencies towards deterioration, caused by the same mechanism; the marginal benefit for 'rational, self-interested' actors of not cooperating to protect the good in question. Whether conventional economists describe the problem of DACC in terms of a global commons or a global public good, therefore, its explanation is located in the same place; the apparent tension between shared costs and benefits with *the individual rationality* of each GHG emitting actor (individuals, companies or governments), for whom the benefits of reducing emissions *by them alone* are seen as negligible compared to their personal cost in reducing emissions.

2. Relevance of game theory to understanding DACC.

2.1. The deadlock problem

One immediate concern with this analysis is that there seems to be no prospect for emerging at all from the deadlock[53]. Because, of course, it applies to national actors, and implies that none of the solutions argued over – either market-based or state-based - will ever be implemented without an international agreement and binding commitments. But why should any current government at an international level commit to an agreement in the first place, if it will have to make an immediate sacrifice which outweighs any immediate benefits?

Stephen Gardiner draws out these kinds of pessimistic conclusions from the Hardinian commons analysis (although it applies equally to "public good" game theoretical descriptions of DACC[54]). The deadlock is particularly entrenched in the case of climate change, Gardiner argues, because the commons problem is spread between generations[55]. Applied to DACC, the Hardinian analysis implies a prisoner's dilemma scenario, not only

[53] Although this does not constitute a reason for believing it to be incorrect, i.e. we may in fact be all doomed.
[54] E.g. Grasso, 2004, p13
[55] Gardiner, 2006, p402

because the costs of climate deterioration are shared amongst all people globally, but because "climate change impacts are *seriously backloaded*... and the full, cumulative effects of our current emissions will not be realised for some time in the future".[56] This is "likely to undermine the will to act", since "the benefits of emissions accrue largely to the present"[57]. This means, Gardiner suggests, that even if an international agreement is needed to resolve the cross-nation prisoner's dilemma through co-operation, some current national governments lack incentives even to co-operate in the first place because "one cannot appeal to a wider context of mutually beneficial interaction, nor to the usual notions of reciprocity [i.e. those used to explain co-operation between contemporaries]" between current and future generations[58].

But if this is so, solving the deadlock appears to require pursuing the market-driven policies of the neo-classical agenda, even though Hardin originally argued that either state-based or market-based policies can present solutions to commons problems. This is because, following game theoretical logic, what is required at an international level (where there is no equivalent of the state that to operate beyond individual national interests) are policies that can ensure that an agreement comes to be in the economic interests of each (international) actor, through, for example, flexibility mechanisms, carbon trading and other forms of carbon pricing[59]. And for neo-classical economists, this is not only a pragmatic solution, but the preferred approach over, say, regulation or rationing, in order to economically optimise use of the global commons. Because the market can then perform the trade-offs between the environmental damage from one extra unit of emissions against the economic benefit gained by its emission in a way that governments cannot. It is, under this view, therefore, economically more efficient, lowering costs overall, and promotes economic growth, stimulating the global economy through the new market activity. This is the logical extrapolation from understanding the dynamics of DACC as grounded in marginal cost-benefit analysis (CBA), which I return to later in section 2.2.

However, as I shall suggest next, this kind of game theoretical analysis does not fully capture the structure of DACC as an international problem and overlooks the social,

[56] Gardiner, 2006, p403
[57] Gardiner, 2006, p404.
[58] The analogy of intergenerational and intragenerational cooperation seems in any case to be spurious because of the dependence of future generations on our actions now. I consider this asymmetry further in chapter 2, section 3.3.
[59] See Hamaide, 2003 which I discuss in section 2.2.

historic and economic context. And if the diagnosis is wrong, the market-based solutions it implies may not be appropriate. The following criticisms focus on the "commons" description of DACC by conventional economics, but again hold equally for the alternate "public good" description, since what is criticised is the shared game-theoretical understanding of the structure of the problem.

2.2 The inevitability problem

A significant difficulty for Hardin's game theoretical analysis as an explanation for DACC is that it suggests a structural feature of *all* commons goods such that they will inevitably descend into overexploitation. It assumes, as Feeny et al highlight, a necessary "divergence between individual and collective rationality"[60]. But the problems with this kind of claim have been highlighted through widespread criticism of the original analysis and contention over whether Hardin's village commons scenario is historically accurate. Hardin, Dietz et al have pointed out, "missed the point that many social groups, including the herders on the commons that provided the metaphor for his analysis, have struggled successfully against threats of resource degradation by developing and maintaining self-governing institutions"[61]. Similarly, Rowe reiterates E.P. Thomson's reminder "that the commoners themselves were not without common sense'."[62], and co-operated on commons maintenance. Rather, Rowe argues, the tragedy thesis was a justification for enclosure, "a mass eradication of a [common] property right"[63]. Only in an "ownership society" does the idea of something that "belongs to all of us together" seem problematic when we are used to thinking of things belonging "to each of us apart"[64]. He argues that Hardin's proposed privatisation solution in fact has a greater tendency towards overexploitation because of motivations to maximise short-term profits from the resource.

Susan Buck likewise argues that decline in the commons was the result of other historical forces, and not inherent overuse. Those who shared access were also responsible for its care, and access was restricted to those in the village, whose use was regulated; the aim of common use was not to maximise personal gain but to co-operate in its management as a

[60] Feeny et al, 1990, p2
[61] Dietz et al, 2003, *review* section (no page references since html file only available)
[62] Rowe, 2005, p57
[63] Rowe, 2005, p56
[64] Rowe, 2005, p54

community. Ostrom examines many such cases[65], as do Feeny et al who argue that, "In many societies… the capacity for concerted social action overcomes the divergence between individual and collective rationality"[6667] Buck highlights van Potter's suggestion that "the tragedy of the commons" is not "a defect in the concept of 'commons' but... a result of a disastrous transition period between the loss of an effective bioethic and its replacement by a new bioethic that could once again bring biological realities and human values into a viable balance"[68]. Dietz et al have similarly argued that "A set of rules crafted to fit one set of socio-ecological conditions can erode as social, economic, and technological developments increase the potential for human damage to ecosystems and even to the biosphere itself"[69]. What is suggested, then, is that there is nothing inherently problematic or tragic about commons which were "managed successfully by communities" for centuries and continue to be so managed in other countries[70]. The problem arises when human systems change, and governing "rules" do not "evolve"[71] to ensure these conditions are still met.

These criticisms are more than disagreement over a particular historical event . They have implications for the kind of economic analysis itself involved in understanding DACC, its assumption of the inevitability of degeneration of commons and the structural understanding of human economic relations to them[72]. For, Hardin presents the "tragedy of

[65] See e.g. Dietz et al 2003; Ostrom 2000. In both, design principles are considered that seem to guide successful commons management. Ostrom, 1999 also shows how evidence from "experminents of appropriation dilemmas" does not support the model of "human actor" as a "norm-free, myopic, and maximizing individual" (p496).

[66] Feeny et al, 1990, p13. Similarly, Norberg-Hodge observes how in Ladakh society the "good of the individual is not in conflict with that of the whole community... Ladakhis are aware that helping others is in their own interest... Mutual aid, rather than competition, shapes the economy. It is, in other words, a synergistic society". Norberg-Hodge, 2000, p51,

[67] Hardin later acknowledged that not all commons were free access, and that his analysis should have alluded to "unmanaged" commons. However, even here, he seems to understand "managed commons" in terms of "either socialism or the privatism of free enterprise" (Hardin, 1998, p683). Whereas, as Feeny et al (amongst others) have highlighted, commons management is not merely limited to "state institutions under representative government"(Feeny et al, 1990, p13). There are a variety of formal and informal ways of communities managing commons use, such that even if nominally use is unlimited, users can recognise moral and social restrictions on their own use, as part of a wider community, and do not necessarily act according to a distinct individual rationality.

[68] Van Potter, cited in Buck, 1985, p54

[69] Dietz et al, 2003, section: Why a struggle?

[70] Buck, 1985, p54.

[71] Dietz et al, 2003, section: Why a struggle?

[72] The argument here is not, therefore, that if Hardin's original explanation was factually incorrect then it must be incorrect for all other commons scenarios. It is that we have no reason to believe that the failure of a commons is inevitable without intervention since communities can self-manage, and are not necessarily motivated individualistically.

the commons" problem as arising from the "inherent logic of the commons"[73] as though individualism – acting according to rational self-interest - were a feature in any commons scenario, of society itself; a rationality of the individual always in conflict with common interests. But there seem good reasons to understand this as reflecting instead a particular *kind* of decision-making which need not prevail. I return to this shortly.

But the question will be how far this yet applies to DACC as a global phenomenon, where the moral and social norms governing a small community are not present. Even then, it is not clear that the logic of individualism must determine the fate of all global commons. De Sombre points to the success of the Montreal agreement to highlight the inadequacy of game theory in explaining the decision-making behind global commons problems. Montreal was, she suggests, a recent case where a solution to the global commons ozone problem was agreed on, even though the reduction of CFCs bore a significant industrial cost. Additionally, that nations recognised the need for a climate change agreement and began the process at all suggests that something more than narrow self-interest is at work. She argues:

> "That we can cooperate on these issues where most of the benefits accrue to those not yet alive suggests that the kind of self-interest assumed in game theory is inadequate to explain decisions by policy-makers"[74]

Similarly, Hamaide has emphasised that there are very different ways of looking at international cooperation on DACC which lead to potentially very different outcomes. He distinguishes "economic" forms of cooperation, based on "economic rationality" from "political cooperation" which includes other, predominantly ethical, concerns, such as "equity and historical responsibility"[75].

The "economic" approach to cooperation follows game theoretical lines. Hamaide examines the estimated costs and benefits for five different international regions from emissions abatement action. If each region seeks to maximise its own benefit[76], it takes a non-cooperative strategy. Accordingly, Hamaide's figures imply that United States and

[73] Hardin, 1968, p162
[74] De Sombre, 2004, p42
[75] Hamaide, 2003, p172-173
[76] Hamaide, 2003, p172

China would not abate since "their own abatement cost is larger than their own benefit"[77]. Alternately, if it is decided to maximise global rather than regional benefits, "internalizing the externality", then "full cooperation" can be achieved. But only if "developing nations bear most of the abatement burden… because their marginal abatement cost is lower than in the developed world" and if "south-north transfers are accepted, that is as long as poor countries attract rich countries in the coalition by side payments"[78]. Clearly Hamaide's precise figures are subject to debate. But even if the thresholds change for countries economically benefiting from mitigative action, the costs and benefits of different countries will still vary, as will, according to this economic rationality[79], who will agree to mitigate. The overriding concern driving mitigation negotiations is economic efficiency; cost minimisation either at a national or international level.

However, as Hamaide points out, cooperation on DACC can be understood "politically", and "other considerations" are also relevant, and even overwhelming. He rightly argues that " even if it is economically efficient, it is not politically acceptable" to have " transfers from the south to the north", and "Cooperation in the economic sense should be... supplemented and even overthrown by cooperation in the political sense incorporating equity and historic responsibility"[80]. The difficulty is that the "economic" understanding of cooperation has in fact tended to dominate the DACC debate. This means that whilst De Sombre and Hamaide are correct in highlighting the *possibility* of other bases for policy decisions, the problem of DACC has arguably conformed to the game theoretical analysis in a way that Montreal and other agreements did not.

And this indeed is the kind of point Gardiner himself makes in considering the implications of the Hardinian analysis for DACC. He agrees that game theory is "misguided in general... because it assumes that individuals and states are motivated exclusively by self-interest."[81]. But he thinks that it is applicable in cases like DACC where "some form of self-interest happens to be dominant"[82]. Whilst he believes that "any solution to the

[77] Ibid.
[78] Ibid.
[79] I say "*this* economic rationality" because I do not think it applies to all economic approaches. This is worth emphasising since there is a tendency to make "economic" logic synonymous with "neo-classical economic" logic.
[80] Hamaide, 2003, p173
[81] Gardiner, 2004, p25.
[82] Gardiner, 2004, p26

problems... will require calling on motivations other than... narrow, economic self-interest"[83], elsewhere he has argued that the "perfect moral storm" of the "features of the climate change problem" themselves "threaten our ability to behave ethically"[84]. Certainly this kind of explanation does seem to reflect the way in which both actors and commentators often talk about DACC and the barriers to successful mitigation efforts[85]. Governments are unwilling to threaten national economic growth and competitiveness, and political actors, as Gardiner highlights, could also risk their electoral future because of the threat to their voters of immediate sacrifice[86]. But my caution is against sliding towards an acceptance that game theoretical logic is largely unavoidable "in this case", which Gardiner's analysis sometimes suggests. For the crucial question is *why* the problem seems to conform to the modes of behaviour predicted by Hardinian analysis. Gardiner alludes to the dominance of "unreflective consumption behaviour", "based on *perceived* self-interest" which is "often narrowly economic"[87]. Whilst broadly right, this needs to be qualified, for several reasons.

Firstly, DACC affects our lives to a degree that the ozone problem did not, evident from the lock-step between economic growth and emissions[88]. Fossil-fuel dependency is integral to most aspects of our lives: the transport we use, the distance we travel to work and access services, the design of communities and of buildings, the food we eat[89] and the *s*upply chains of the goods that we buy. In this sense the problem is not straightforwardly that, as individuals, people act self-interestedly to continue high carbon-emitting activity which benefits them(although arguably this is also true[90]). Because fossil-fuel dependency permeates every aspect of our lives, emitting activities are the default, and take a very particular effort to avoid. And, even if an individual actor (either a person or a nation) significantly lowers their contribution, the pre-existing emissions-dependent structures

[83] Ibid.
[84] Gardiner, 2006, p398.
[85] See for example the following media reports: Vidal, 2007, regarding the US refusal to participate without China or India; Black, 2006, on reluctance to act if it will "damage competitiveness", and Hunt & Townshend, 2011, who argue that more progress may be made in the 2011 talks because of "increasing recognition of the significant co-benefits of climate legislation".
[86] Gardiner, 2004, p32
[87] Gardiner 2004 p26
[88] E.g. Meyer, 2000, p28
[89] Some food products require vast energy inputs, e.g "2100 kcal are invested to produce zero to 1kcal of consumable energy" for a can of soda (Pimentel et al, 2008, p467) See also McMichael et al, 2007; Friends of the Earth, 2007.
[90] It is evident, for example, the attitudes expressed over the UK switch-over to low-energy lightbulbs. See Derbyshire's Daily Mail article, Derbyshire, 2009.

themselves do not change - the goods and services are used by someone else. It therefore takes an incredible, coordinated effort to severely cut our GHG emissions through altering these structures, and the national impacts of an international mitigation agreement are of a different order to those from Montreal, implying huge financial costs. This does not imply that such a change should or could not happen; so long as the need for the change is recognised. But it makes it far more difficult. It is at this level that "narrow economic self-interest" particularly seems to play a role, in so far as the sacrifices that this might entail constitute a reason to avoid such wide-scale systemic change, and can engender hopelessness or cynicism about the prospects of success.

But secondly, in so far as self-interest does *also* operate at both individual and national levels, it is not enough to assert, as Gardiner does, that it "happens to be dominant"[91] in the case of DACC. If "motivations other than those of narrow, economic self-interest"[92] are possible, it must be questioned why they are not more prevalent. Part of the problem is that this question is not always asked. It is not always recognised that, as Daly and Cobb have argued, neo-classical economic analysis does not simply model how people always behave in the way that physics does in describing physical laws[93]. It abstracts from a particular form of behaviour and human interaction to formulate assumptions about the processes underlying all decision-making. This, they suggest, is what Whitehead described as the "fallacy of misplaced concreteness", i.e. "neglecting the extent to which our concepts are abstract, and therefore also neglecting the rest of the reality from which they have been abstracted."[94]

This precludes the possibility of the alternative modes of behaviour and systems of governance suggested earlier by Buck and Ostrom. Because these abstractions in turn influence reality: economists are not merely neutral observers, but promote a particular world view. Daly and Cobb describe, for example, the neo-classical economic abstraction of "*Homo economicus* from real flesh and blood human beings"[95]. Homo economicus builds in two assumptions: that human "wants are insatiable"[96] and people are indifferent to

[91] Gardiner 2004 p26
[92] Ibid.
[93] Daly & Cobb, 1990, p28-32. See also Read 2007a, p318, cited in the thesis' Introduction
[94] Daly & Cobb, 1990, p36
[95] Daly & Cobb, 1990, p85
[96] Ibid.

the desires of others[97], i.e. “extreme individualism”[98] or 'rational' self-interest. Whilst economists often recognise this as abstraction[99], they “typically identify intelligent pursuit of private gain with rationality, thus implying that other modes of behaviour are not rational... economists have taught us to think that checks on self-interest are both unnecessary and harmful. It is through rational behaviour, which means self-interested behaviour, that all benefit the most”[100]. Thus “the use of the model influences actual behavior away from community-regarding patterns towards selfish ones”[101].

This also influences society through guiding policy that structures it, e.g. the operation of the market and pursuit of growth in GNP as “a measure of economic success”[102] - ignoring “the degree of abstraction” or “connection to the real world”[103]. For, as Schumacher has also highlighted, “Although it is, of course, society that produces the production system, once a particular system has come into existence it begins to mould society: it... insists that the members of society respect the immanent logic of the system and adapt to it by accepting its implicit aims as their own... The prevailing concept of efficiency rules the modern world not by itself but by the type of technology and organisation it has produced.”[104]. The mode of economic organisation promoted by conventional economics – individualistic, high-consumption, growth oriented, around which our society is constructed – is both what feeds and locks in our economic dependency on fossil fuels[105] and what limits our ability to move to a cooperative solution[106]; to move to a different “bioethic”[107], which, as suggested earlier, would allow for more effective commons management. Because, as I argue in the next section, the neo-classical economic model,

[97] Daly & Cobb, 1990, p86

[98] Daly & Cobb, p87

[99] Including Milton Friedman, who as Rowe highlights, “famously argued that it made no difference whether or not homo-economicus was an accurate portrayal. The economy worked as though it was, and so what difference did it make?” (Rowe, 2009)

[100] Daly & Cobb, 1990, p5-6

[101] Daly & Cobb, 1990, p92

[102] Daly & Cobb, 1990, p63

[103] Daly & Cobb, 1990, p95-96)

[104] Schumacher, 1993b, p166

[105] See e.g. Benton, 1999, p217- 222 on the tendency of “commercial logic” to “stretch and override its boundary conditions” socially and ecologically, at a global level. Also Meadows et al, 2005, considered in section 3.1.

[106] Hirsch, for example, argues that “The social morality that has served as an understructure for economic individualism has been a legacy of the precapitalist and preindustrial past.” and has “diminished with time and with the corrosive contact of the active capitalist values... As individual behavior has been increasingly directed to individual advantage, habits and instincts based on communal attitudes and objectives have lost out.” (Hirsch, 1976, p117-118)

[107] Van potter, cited in Buck, 1985, p54

through CBA as a decision-making tool and its institutional form of the market, does not recognise the social and ecological features of reality necessary to redirect economic activity according to either ecological effectiveness or equity.

In so far as game theoretical analysis seems relevant to understanding the global climate commons, I am suggesting that it points not to an inevitable structural feature of all commons and public goods, but the way in which narrowly economic considerations have dominated decision-making on DACC, over and above other ethical or political considerations. Rather than a "tragedy of the commons", it is better described as a "tragedy of economics"[108].

3. The Tragedy of Economics; the elimination of ecological effectiveness and equity.

The relevance of game theoretical analysis to DACC is not simply its explanatory limits but the barriers it places towards reaching a solution. For, the neo-classical economic approach promotes an understanding of the world and a means of decision-making that precludes explicit consideration of ecological effectiveness and equity. This is through CBA, or, relatedly, the 'invisible hand' of the market. Both operate through interpreting qualitatively distinct aspects of social and ecological reality in a quantitative manner, so that they can be made commensurable on a single monetary scale[109]. This is then amenable to aggregating different costs and benefits in CBA, or to theoretically justify how the market mechanism optimally allocates resources through arbitrating between different individual preferences, expressed and unified through price. This includes, as I discuss in section 3.2, and as Marx noted[110], the exchangeability of different kinds of goods and services, more recently criticised as the lack of substitutability between different kinds of capital – 'social', 'human-made', 'human' and 'natural'[111]. It also includes, as alluded to

[108] Rowe has also made this suggestion, in Rowe, 2009, although I developed the phrase independently.
[109] I.e. it assumes "strong commensurability" - see O'Neill, 1993, p99 for the strong/weak distinction
[110] I.e. the notion of commodity fetishism whereby the exchange value of commodities is mistaken for being its objective property , the "physical nature of the commodity" and "the fantastic form of a relation between things"(Marx, 1990, p165) But this is impossible because of they have different (qualitative) use values – their "sensuously varied objectivity as articles of utility" (p166), and exchange value is created by the process of exchange whereby men "equate their different kinds of labour as human labour"(p166), and therefore in fact reflects the "definite social relation between men themselves"(p165).
[111] Daly, 1997, p76 and Goodland and Daly, 1996, p1006

earlier, a quantitative reductivism of the various goals or values which often guide decision making and which emphasise as relevant these qualitatively distinct features of reality. These are reconceived as individual preferences or utility functions, which can be satisfied to varying quantifiable degrees, and understood on one financial scale of costs and benefits[112].

The difficulty is that this conceptual approach *ignores* crucial social and ecological qualitative features of reality. These need to be accommodated both to explain how the problem of DACC has emerged in conformity to a commons tragedy and, therefore, to work towards a policy solution. In particular, the conventional economic approach undermines two of the criteria for an agreement described in section A, ecological effectiveness and equity. Because these are reduced to and thereby replaced by the third criterion, (economic) efficiency, which seeks to optimise financial outcomes across all kinds of costs and benefits. Whilst conventional neo-classical economics fails to acknowledge the concerns of the other two criteria at all, more recent extensions such as environmental economics attempts to accommodate them, I will argue, equally unsuccessfully. I will outline some of the main problems with such reductivism here, but will return to these difficulties in more detail when I discuss the interpretation of Ecological Effectiveness (chapter 2) and Efficiency (chapter 4).

3.1. Core Neo-classical Economic treatment

The core of the conventional economic paradigm, in its neo-classical form, ignores social and ecological aspects of reality in a straightforward and well established manner. That is, as standardly explained in economic textbooks, costs and benefits to the environment and to wider society that do not accrue directly to economic actors involved in a particular transaction are considered "externalities"[113], and are not accounted for by economic analysis, or the market itself. Concern for wider social and ecological ends are accommodated only in so far as they are counted as preferences of individuals that hold them. These in turn affect economic activity only in so far as they alter supply and demand which is itself driven primarily by financial cost.

[112] See O'Neill, 1993 chapter 7 regarding the failure of CBA to accommodate the plurality of values.
[113] Reardon, 2007, p385.

A key ecological feature ignored in this way is the ecological limit to total economic growth, which is crucial to recognise in preventing overexploitation of a commons. It was discussed in 2.2. that the equation of a "commons" with a free access good was problematic because in a genuine commons scenario users do not see access as "free" – they are self limiting, either informally because they recognise the impact of their use on others and overall limits, or more formally through community regulation of the commons. It is this recognition and the ability to act in accordance with it that has allowed for successful commons management, and which has been undermined by conventional economic models. Under the methodological individualism of neo-classical analysis, there is no means to account for these limits since economic transactions are understood at an individual level, guided by the immediate costs and benefits to those actors alone.

The problem of DACC can be seen as the result of a failure to recognise the limits to economic growth from the atmosphere's carrying capacity for GHGs. In so far as there has been a historic ignorance of the existence of an atmospheric 'carrying capacity' for emissions or the importance of emission sinks, this might be argued to be a circumstance unrelated to economics. But the problem can be seen as the reverse, lying precisely in the initial assumption of the limitlessness of economic growth and the failure to anticipate or acknowledge the possibility of limits of an ecological kind.

This is the kind of point made by Meadows et al in their famous consideration of the "Limits to Growth". They describe the concept of system "overshoot"; a combination of rapid change, limits to that change and delays in perceiving the limits or in controlling the change in a system means that it "overshoots" its limits[114]. When this occurs in an *economic* system overshooting environmental limits, this can lead to "catastrophic overshoot"[115]. This can occur either in terms of reserve limits (a "nonrenewable resource crisis"), or pollution limits (a "global pollution crisis"). In the former, short reserves of non-renewable resources are not recognised by the economy which continues to use them at an increasing rate, then overshoots and collapses because it has exhausted the resource base for its growth, and in the latter, longer reserves of non-renewable resources mean that increased production by a fast growing economy proceeds too fast to recognise pollution signals until it is too late[116]. It takes, for example, significant time for "forests to regrow...

[114] Meadows et al, 2005, p1
[115] Meadows, et al, 2005, p2.
[116] Meadows et al, 2005, p171-174

pollutants to work through the ecosystem, for capital plants to depreciate"[117], during which time increased quantities of these reserves have been used by the expanding economy. They argue that "overshoot comes from delays in feedback" and "is possible because there are accumulated resource stocks that can be drawn down". Accordingly, "If a society takes its signals from the single availability of stocks, rather than from their rates of replenishment [or, in the case of pollution limits, their effects], it will overshoot"[118]

In the case of DACC, the physical basis for economic growth has been the availability of cheap energy in the form of fossil fuels. But the conventional economic model has no mechanism for recognising limits: either to future availability, or to the polluting effects of their use. The "physical momentum"[119] of the economic system, is driven and limited only by current stocks of fossil fuel reserves. Although, therefore, economics is conventionally understood as describing the allocation of scarce resources, it does not recognise all aspects of scarcity. For, a further crucial feature of this tendency towards overshoot comes, as Meadows et al argue, from the "pursuit of growth". Delays in feedback can be handled "as long as the system is not moving too fast to receive signals and respond before it hits the limit", but the increased industrialisation and economic growth over the last fifty years has put this at risk. Even since the commencement of the UNFCC in 1992, emissions rose 38% by 2007[120].

Meadows et al offer an alternative to Hardin's explanation for commons degradation. They argue that, "An unregulated market system governing a common resource with a slow regeneration rate inevitably leads to overshoot and the destruction of the commons"[121]. This describes the "tragedy of economics" in so far as its structures create the conditions for commons overuse. But part of the tragedy is also that conventional neo-classical economic analysis would be unable even to recognise or model the problem in this way.

Why this is so is evident from Daly's criticism that conventional economic analysis is designed for efficient allocation, but unable to cope with issues of economic scale. He argues that it fails to model the environment's existence in even a minimal way. Daly

[117] Meadows et al, 2005, p175.
[118] Ibid.
[119] Ibid.
[120] http://www.globalcarbonproject.org
[121] Meadows et al, 2005, p253

recounts[122] how a diagram depicting the economy-environment relationship in a draft World Bank report, "Development and the Environment", only represented the interaction through "a square labeled "economy" with an arrow coming in labeled "inputs" and an arrow going out labeled "outputs"". There was, he highlights, no representation of limits on the flow of these inputs and outputs. But this is not unique to that report; Reardon notices this omission in economy-environment representations in economic textbooks[123]. The neo-classical core of conventional economic analysis cannot, therefore, recognise the criterion of ecological effectiveness to guide an international solution to the problem, since it does not have the conceptual tools to recognise the ecologically limiting features of the world on which the criterion depends.

And, as Daly points out, neither does it recognise or promote distinct social ends such as distribution[124], which includes the second criterion for an agreement, equity. This manifests in conventional economic approaches to DACC. Padilla highlights how for conventional economic CBA, the goal of "global efficiency" can be achieved by mitigating emissions primarily in poorer countries which are assumed to have lower reduction costs[125][126]. Because, as Toman argues, conventional economics blurs distribution issues by treating the world "as a single unit", across which costs and benefits are optimised irrespective of the unequal outcome in emissions distribution between nations[127]. Similarly Shue has criticised Stewart and Wiener's proposal for a "comprehensive" treaty that allows for "homogenizing calculations" of cost-effectiveness of mitigation for each country. This "comprehensiveness", Shue argues, "obscures distinctions that are fundamental"[128]. He criticises the "standard economic analysis" treatment of all welfare considerations as reducible to preference, irrespective of qualitative differences. For, he argues, "The satisfaction of some 'preferences' is essential for survival, or for human decency"[129]. I discuss this further in chapter 3 in considering the Equity criterion.

[122] Daly, 1997, p6
[123] Reardon, 2007, p385.
[124] Daly and Cobb, 1990, p59
[125] Padilla, 2004, p534
[126] Or, even more worryingly, as noted in 2.2., the implications of operationalising the Kaldor-Hicks compensation criterion for pareto efficiency are that compensation should be paid by the poor to rich for mitigating at all (Padilla, 2004, p531).
[127] Toman, 2006, p2
[128] Shue, 1993, p56
[129] Shue, 1993, p55.

Accordingly, neo-classical economic analysis does not consider inequities in use of emitting activities between countries, and promotes efficiency at the expense of equity. But importantly, to return to the discussion in 2.2, advocating this economic model to guide policy *also* promotes acting in accordance with unmitigated self-interest as the rational basis for policy, in order to determine what is optimal, or economically efficient. The conformity of international actors to the methodological individualism of Hardin's commons tragedy is thereby justified by economic theory.

The neo-classical core of conventional economics, then, does not accommodate either ecological effectiveness or equity, both of which are essential for avoiding a commons tragedy. As Daly and Cobb put it, "the market sees only efficiency – it has no organs for hearing, feeling, or smelling either justice or sustainability"[130]. Where other criteria *are* recognised as relevant independently from economic analysis, no attempt at ordering or prioritising is made. Rather it is seen straightforwardly as a trade-off. Baert Wiener, for example, describes how "Earlier reductions may protect the climate more because they prevent the build up of gases that reside in the atmosphere for decades afterwards. But later reductions may cost less."[131]. This trades-off ecological effectiveness and efficiency (understood as cost-minimisation). His response is not to consider their relative importance and offer a justification, but to treat both analogously to competing preferences in economic analysis. That is, a compromise is proposed for "optimizing" abatement over time, by giving ten year emissions budgets to countries who then use CBA to decide how to spread reductions over that period[132]. However, there have been some attempts to accommodate ecological limits in adjustments to the paradigm, which I consider in 3.2.

[130] Daly and Cobb, 1990, p145
[131] Baert Wiener, 2002, p174
[132] Baert Wiener, 2002, p174-175

3.2. Environmental Economic accommodation of ecological concerns.

In recent years, as damage of economic activity on the environment has become increasingly evident, conventional economics has attempted to adapt. This is through efforts in Environmental Economics[133] to internalise externalities; by pricing environmental (and to some extent social) costs and benefits[134] for inclusion in the calculations of the market and in CBA to guide business or policy decisions[135]. This attempts, to use Daly and Cobb's turn of phrase, to allow the market to hear, feel or smell sustainability. This can take the form of Pigovian taxes, estimated so as to reflect the value of the negative externality (or subsidies to reflect positive externalities). In CBA, costs and benefits are valued through, for example, attempting to reflect the financial cost of the externality, (such as the cost to the public purse of treating health problems resulting from localised pollution) or through willingness to pay (WTP) assessments, often by surveying how much ordinary people would be willing to pay to protect positive or prevent negative externalities[136].

These 'internalising' procedures have been subject to numerous criticisms, which I will not fully reproduce here, but which range from abhorrence at the thought of 'pricing' nature or human costs such as health, to concerns over the practicalities in overcoming the arbitrariness of prices that individuals suggest they are willing to pay to protect parts of the environment[137]. My main concern, however, is that again, morally relevant and structurally necessary features of social and ecological reality are still ignored, even if formally acknowledged when treated as commensurable and exchangeable on the same monetary scale. Because by so doing, qualitatively distinct values and policy criteria such as

[133] Environmental Economics is broadly distinguished from Ecological Economics as follows: the former accepts the assumptions of neo-classical economics regarding the optimising role of the market, and aims largely to modify the model to accommodate environmental 'externalities' and correct for particular environmental problems; the latter reconsiders economics in the context of the functioning of the ecosystem as a whole, the relations between the economy and ecosystem, and brings other values and disciplines to bear on economic interactions. See Van den Bergh, 2001 for a more detailed examination.
[134] However, the prominent ecological economist, Costanza, (founder of the "Ecological Economics" journal; see Costanza, 1989) has adopted the practices of environmental economists of pricing the environment to reflect its economic value (e.g. Costanza et al, 1997). There is, therefore, a question about how distinct, for Costanza, ecological economics in fact is in practice from environmental economics, and there seems to be some tension within ecological economics to the extent that such practices still occur. There is not space to examine this here, but it warrants further consideration.
[135] Benton, 1999, p214
[136] This involves effectively pricing human lives, a practice that has received much criticism, in particular because it normally involves discounting, which I discuss briefly in chapter 2, section 3.2.
[137] See e.g. Sarkar, 2005, p188-195

ecological effectiveness and equity are effectively *replaced* by financial efficiency. For instance, even in the traditional neo-classical approach to CBA, not even all costs and benefits of participants in the economic interaction are included in the monetary exchange. For example, consumers might financially benefit but suffer worse medium/ long-term health, if they select cheaper processed food options over more expensive but nourishing ones.

But even when these other kinds of (e.g. health) costs are accounted for in economic analysis through translation to financial costs, this fails to capture the way in which they are important. This materialises in the debate over weak and strong sustainability, and the problem of substitutability (a parallel problem to that of commensurability). Environmental economics adopts a weak sustainability position[138], which, as Goodland and Daly have pointed out, assumes the substitutability of different kinds of 'capital'; goods and services that are used and exchanged in our economy, which might be "natural", "human", "human-made" or "social"[139]. Although weak sustainability recognises the role that so-called "natural capital" plays in our economy, it seeks only to maintain the "total capital intact without regard to the partitioning of that capital among the four kinds". This ignores the crucial roles that distinct kinds of of 'capital' may play, either directly in our economy, or in supporting the social or biological integrity it depends on. If, for example, all forests were cleared, the many roles that they had played would not be reproducible with other goods and services – the fuel and material they provide, the habitat and local ecosystemic role, or their part in wider ecological processes such as CO_2 uptake, for instance.

This emphasises the importance of "maintaining different kinds of capital intact separately"[140], and supporting instead a "strong sustainability" perspective. How far even this is a sufficient improvement may be doubted, since for similar reasons we can highlight significant distinctions between different kinds of 'natural capital'[141]. But either way, assuming *total* substitutability, as in environmental economics, ignores what Goodland and Daly refer to as "complementarity". 'Natural capital', for example, is a complement for human-made capital, because it is required *for* human-made capital, and its destruction or

[138] Van den Bergh, 2001, p17.
[139] Goodland and Daly, 1996, p1006.
[140] Ibid.
[141] This, is the move behind opting for a third category of sustainability, which Goodland calls "absurdly strong". Though perhaps harder to implement in practice, since it simply follows the same logic of the previous move there seems no reason to suggest that this is necessarily "absurd".

degradation cannot (always) be compensated for in any meaningful way. Daly thus criticises Nordhaus for arguing that "global warming would only have a small affect on the US economy"[142]. Nordhaus assumed, Daly recounts, that if agriculture is the main casualty of DACC, this only accounts for 3% of gross national product. What Nordhaus ignores is the role of agriculture in relation to other industries; that everything else is dependent *on* it. Daly pictures the relationship as a growing "inverted pyramid" with agriculture at or near the point at the base. Agriculture is the resource base that everything else depends on, and is holding up the "pyramid of value added"[143].

This model of economics will similarly fail to adequately accommodate ecological limits to growth. For these are incorporated only as the cost of environmental degradation from each additional unit of economic activity, and therefore treated as simply another cost to be weighed against other kinds. Indeed, the environmental economic approach dominated by economic efficiency still assumes the possibility of and need for continued economic growth. Environmental economic assessments of climate change policy imply that emissions reductions sufficient to prevent DACC can be achieved with only a negligible affect on growth[144]. However, this seems to overlook the effects of mitigation on growth itself. To return to Goodland and Daly's earlier points, it ignores the relationship between different kinds of 'capital'. As was highlighted, economic growth has arisen from the availability of cheap energy from fossil fuels. Many have noted the lockstep between emissions growth and GDP[145]. Whilst some, like Meyer, remain in theory open to the possibility that the lockstep can be broken, if economic growth remains the goal, even were the relationship to be widened, increased economic growth requires ever deeper emissions reductions to compensate, and growth pressures conflict with mitigation efforts[146].

Accordingly, some, like Anderson and Bows, have argued that they are totally incompatible. Even with optimistic assumptions, they argue, stabilising emissions at

[142] Daly, 1997, p63
[143] Daly, 1997, p64
[144] E.g. Stern (2006, p211), argued that it would cost between -1 and 3.5% of GDP per year to reduce emissions by three-quarters by 2050, which he envisaged as consistent with a 550ppm CO_2e stabilisation level (see chapter 2 section 4 for my concerns with this target). Even Padilla (2004, p526), otherwise critical of conventional economic techniques, suggests that only 2% of global GDP is required "to make a significant difference in the control of emission", equivalent to postponing "the GDP of 2050 to 2051".
[145] E.g. Meyer, 2000, p28
[146] Because, as Li points out, even with renewables, "The equipment and buildings required for "renewable" electricity need to be built by the industrial sector using fossil fuels and non-renewable mineral reosurces". (Li, 2008, p3)

450ppm CO_2e (which is still reasonably likely to exceed 2 °C global mean temperature[147]; see chapter 2, section 4[148]) requires "global energy related emissions to peak by 2015, rapidly decline at 6-8 per cent per year between 2020 and 2040, and for full decarbonisation sometime soon after 2050"[149]. However, they argue that these reductions are not achievable whilst pursuing economic growth, and highlight Stern's claim that annual "reductions of greater than 1 per cent have only 'been associated with economic recession or upheaval'", such as the collapse of the Soviet Union, which only brought roughly 5 % annual reductions[150]. They further argue that "orthodox studies" constrain reduction rates to "levels thought to be compatible with economic growth – normally 3 per cent to 4 per cent a year"[151], and conclude that "dangerous climate change can only be avoided if economic growth is exchanged, at least temporarily, for a period of planned austerity within Annex 1 nations", i.e. a "planned economic contraction"[152]. Others have drawn similar conclusions[153].

3.3. Accommodation of equity in conventional economics.

Whilst Environmental Economics was an attempt to internalise environmental externalities, there has been no fully analogous move to accommodate distributional concerns into neo-classical economics. Attempts are sometimes made to reconceive them as problems in economic efficiency. For example, although the World Bank's 2006 report on Equity and Development highlights the moral, religious and developmental significance of equity, it emphasises its key concern that, "With imperfect markets, inequalities in power and wealth translate into unequal opportunities, leading to wasted productive potential and to an inefficient allocation of resources."[154]. This enables them to suggest that "equity is complementary, in some fundamental respects, to the pursuit of long term

[147] Meinshausen, 2006, p266.
[148] I argue that both the temperature target and atmospheric concentration should be far stricter
[149] Anderson and Bows, 2008, p3877. Total CO_2e emissions would require 4 per cent per year reductions, but much of these emissions are from non- CO_2e GHGs such as methane and nitrous oxide which are mostly from food production. Anderson and Bows have assumed non- CO^2 GHGs can be reduced to 7.5Gt CO_2e by 2050, a halving of the emission intensity of current food production, with alternative early, mid and late peaking years. (p3869-3871).
[150] Anderson and Bows, 2008, p3878.
[151] Anderson and Bows, 2011, p40
[152] Anderson and Bows, 2011, p41
[153] Li, for example, argues that to achieve the emission reductions necessary for a 445 ppm CO_2e stabilisation, given various scenarios in energy & emissions intensity declines, the maximum world growth rate permitted runs from -3.4 to -0.7%, i.e. the global economy would have to contract. (Li, 2008, p6-7).
[154] The World Bank, 2006, p7. This point is also made by Woodward and Simms, 2006, p7.

prosperity", and that the solution lies in "pro-poor" growth[155], or "some forms of redistribution— of access to services, assets, or political influence" to "increase economic efficiency."[156]. This latter approach is also evident in the social democratic trends of Western market economies which, whilst adhering to the growth model of the market economy, simultaneously advocates a degree of social justice through the welfare state and progressive taxation to correct for the inequities of the market (for example, in former UK Prime Minister Blair's "Third Way".[157]).

However, Woodward and Simms have highlighted that attempts to promote both economic growth and equity assume "conceptual separation of income growth and income distribution"[158]. Whereas, they argue, these are, rather, "two ways of summarising the same set of variables… so if one changes, the other will almost certainly change too". They suggest the question is overlooked regarding "whether economic policies designed to promote growth affect distribution"[159]. Just as conventional economists argue that certain redistributive measures weaken growth, growth policies increase inequalities because richest incomes also increase. This is, after all, the purpose of pursuing poverty alleviation through economic growth, to create a "positive sum game", where all gain. Relative poverty, they also highlight, then increases, which is as relevant for poverty as absolute wealth[160]. The most effective way to reduce poverty, they argue, is instead through redistribution[161] from the richest to the poorest, instead of 'pro-poor' growth.

Recognising the ecological limits to growth also emphasises why equity is integral to alleviating poverty, because, as suggested in section 1, these limits create a zero sum game. As Galbraith has put it,

> "Were growth to come to an end, income would no longer increase, and the overwhelming question would be 'How is the fixed total to be shared?' For each

[155] The World Bank, 2006, p127.
[156] The World Bank, 2006, p2.
[157] Dickerson, 1999.
[158] Woodward and Simms, 2006, p7.
[159] Ibid.
[160] Woodward and Simms, 2006, p10. This is because many social "goods" and "bads" are competitive. See my discussion in chapter 3, section 5.2., and see Hirsch, 1976.
[161] See Woodward and Simms, 2006, p18 for figures.

person's increase there would have to be a decrease somewhere else. Income distribution would become an extremely urgent issue…"[162]

I examine this further in chapter 3, where I consider the implications of emissions limits for principles of equity. But conventional economics does not recognise growth limits or see equity as being of central economic relevance. It requires, as with attempts to address environmental externalities, 'political' values imported from outside of the model, which, as has been suggested, are in tension with the outcomes it promotes. Daly and Cobb have described all such ways of dealing with externalities as "ad hoc corrections introduced as needed to save appearances, like the epicycles of Ptolemaic astronomy"[163]. The overriding goal of neo-classical economics remains financial efficiency, which obscures the reasons that different kinds of costs and benefits are valuable, their relative importance and the embeddedness of the economy within a social and environmental context. This threatens our ability to understand how these relationships work. In the context of DACC, the content of an international agreement must rest instead on an approach that better models these relationships and why they are important.

[162] Galbraith and Salinger, 1979, p155.
[163] Daly and Cobb, 1990, p37.

C: The Green Economic alternative

4. The need for a new economic paradigm.

Part B considered the problems presented by the way in which conventional economics understands DACC and the three criteria for an international agreement on mitigation. I suggested that conventional economic understanding of DACC as a "tragedy of the commons" or public goods problem mislocated the cause as arising from an inevitable structural conflict between individual and collective rationality. However, I argued that, rather, this conflict arises in DACC in so far as it is promoted by the game theoretical dynamics of neo-classical economic theory and practice which prioritise economic efficiency at the expense of ecological effectiveness and equity. In this part of the chapter, I explain how Green Economics offers an alternative approach that accommodates these concerns; its understanding of the environment-society-economy relationship, the implications for the three criteria for an international climate agreement, and how it might help reframe the concept of a commons.

The criticisms I offered in Part B of the conventional neo-classical economic approach were directed at both conceptual and moral flaws. It is conceptually flawed, because the way in which it guides policy and behaviour misportrays the dependence of economic activity on social norms and ecosystemic functioning. In doing so, as Daly similarly argues in his "biophysical" critique of the "means" of "growth economists", economists undermine the biophysical basis for their own existence[164]. It is morally flawed because its economics, supposedly value-neutral, leaves no place for explicit moral direction of economic activity, but is nonetheless guided by efficiency which is a normative value[165] and overrides other values – rights, duties, well-being, equality, respect, and so on, which would otherwise shape economic interactions[166]. Here too, I roughly echo Daly's criticism of the "ends" of "growth economists" on an "ethicosocial" basis[167]. For, as Daly and Cobb argue elsewhere, "If all value derives only from satisfaction of individual wants, then there

[164] Daly, 1993a p21-22
[165] Efficiency may be considered a moral value in so far as it is defended using some form of preference utilitarianism. I consider this in chapter 4
[166] This is not to suppose that conceptual and moral dimensions are entirely distinct. Rather, as I shall clarify later regards to my position on the fact/value distinction, I see them as two aspects of the same problem.
[167] Daly, 1997, p35.

is nothing left over on the basis of which self-interested, individualistic want satisfaction can be restrained".[168][169]

What is increasingly called for is a different economic way of thinking – and, correspondingly, of operating - which better reflects conceptually the interactions between the economy, society and the environment, and which allows for ethical direction of economic activity. Andrew Simms, of the New Economics Foundation, suggests that "A paradigm shift is emerging not from politics or ideology, but from a deep fissure opening up between two great continental plates – on the one hand, the way the world does business, on the other, the limited tolerance of the earth's environment that business depends on"[170]. Likewise George Monbiot has argued that "The crisis we face demands a profound philosophical discussion, a reappraisal of who we are and what progress means"[171].

As suggested in part A, it is this kind of new paradigm that green economics, and its variants in ecological economics, attempts to present[172]. It offers an alternative paradigm in so far as it fundamentally reconceives relationships and descriptions of entities within the domain of economics, as well as economic practice. The economy is understood as physically embedded within a social and ecological context and thus subject to their limits, but also, therefore, morally embedded, such that it should operate in accordance with ethically identifiable social and ecological ends which form an inseparable part of the model. I explore this in section 2.

This picture constitutes what Daly calls a new 'pre-analytic vision' to underpin our economic understanding. This term is borrowed by Daly from Schumpeter, who describes a "pre-analytic cognitive act that supplies the raw material for the analytic effort"[173]. It implies a particular ontological conception which is brought *to* reality prior to ones attempt to analyse it – a starting picture or model of how the world is set up which shapes our

[168] Daly and Cobb, 1990, p50-51
[169] They also highlight here that in this sense the market erodes its own moral foundations, since "the market still depends absolutely on a community that shares such values as honesty, freedom, initiative, thrift and other virtues whose authority will not long withstand the reduction to the level of personal tastes..." (Daly and Cobb, 1990, p50).
[170] Simms, 2001, p1,
[171] Monbiot, 2007.
[172] Although Herman Daly is, strictly speaking, an ecological economist, his writings have provided the theoretical underpinnings for green economics.
[173] Joseph Schumpeter, cited in Daly and Townsend, 1993, p5.

perception and interpretation of it. This can be thought of as the starting point which frames economic thinking in a particular economic paradigm. This understanding uses the term "paradigm" as roughly analogous to Kuhn regarding scientific activity, where he suggests that in a paradigm "some accepted examples of actual scientific practice – accepted examples of actual scientific practice – examples which include law, theory, application and instrumentation together –provide models from which spring particular coherent traditions of scientific research"[174]. In the case of conventional, broadly neo-classical economic traditions, these examples would include practices such as CBA which were considered in Section B.

However, such a use is, as Daly acknowledges, to adopt "a bit of poetic license"[175]. Because, firstly, there is a distinction between physical and social sciences[176]. As Daly highlights, the supposed laws "explemplified by… societies" which are said to describe social reality are, unlike physical sciences, not universal, and "become unapplicable as those types of society give ways to others"[177]. In other words, the structure of social reality changes, and, furthermore, as suggested earlier, is influenced by our description of it[178] in contrast to the physical sciences (even if our ontological categories for physical reality do). Secondly, it should be noted that for Kuhn each paradigm defined scientific practice for its duration, that is, what is considered to count as "normal science" at any point[179]. In economics this is not the case to the same extent; other heterodox economic trends have always been present. However, it is arguably the case that the broadly neo-classical conventional economic approach is more than just a dominant trend of thinking – it defines the field through the way economics is taught at least at an undergraduate level[180].

Thirdly and lastly, Kuhn also used the notion of paradigm shifts historically, to describe the process of sudden change between one scientific model (and its corresponding network of beliefs and ontological assumptions) to another, whereas here it is being used normatively, to suggest the need for such a shift. However, the term functions here, as

[174] Kuhn, 1996, p10.
[175] Daly, 1993a, p15.
[176] See Winch, 1990, p66-71. Hutchinson et al, 2008, have argued that social sciences should not be considered sciences at al.
[177] Daly and Cobb, 1990, p29.
[178] Read, 2007a, p318, (cited in the Introduction) and Daly and Cobb, 1990, p93, referenced chapter 1, part B, section 2.2.
[179] Kuhn, 1996, p10.
[180] See Reardon, 2007.

summarised in section 0.3, to emphasise that what is required is not just a different economic system consisting in distinct tools or brands, but an alternative eco-political economy – a different way to understand and organise the economy and conduct economic analysis in the context of distinct social and environmental assumptions and values.

5. Green Economic alternative picture/ ordering of criteria.

5.1 Picturing/modelling the economy-society-environment relationship

I now consider in more detail the "pre-analytic vision" of the economy-society-environment relationship portrayed by the conventional economic paradigm. The core, neo-classical picture would, as discussed in part B, section 3.1, fail to represent these relationships even minimally. The diagram I alluded to, recounted by Daly from a World Bank draft report of the environment-economy relationship, is representative of the "pre-analytic vision" of the conventional economic paradigm. Its depiction of the "square labeled "economy" with an arrow coming in labelled "inputs" and an arrow going out labelled "outputs""[181] represents the economy as unbounded, with no sense of the nature or constraints of its environment (see Fig 1. A) . Daly relates how, on asking the World Bank's chief economist what he believed was the "optimal scale of the macro economy relative to the environment", he replied, "That's not the right way to look at it"[182].

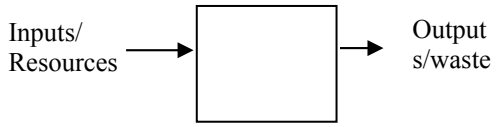
Thus, the economy is depicted as continually expandable, and so far as society is concerned, Daly reminds us of Polanyi's observation, that according to the conventional economy view, "instead of economy being embedded in social relations, social relations are embedded in the economic system"[183]. It then becomes clearer why, under this picture, it appears reasonable to move to an environmental economic position and internalise the environmental (and social) externalities through simply expanding the economy and ignore the concerns raised in section B; there are no limits or constraints, just alterations to the efficiency of the system.

[181] Daly, 1997, p6.
[182] Ibid.
[183] Daly and Cobb, 1990 p8.

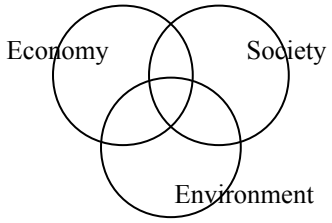
The environmental economic approach might conceivably, however, be represented with another starting point, taken from some forms of the 'sustainability' approach[184]. Here, the three domains of environment, society and economy are depicted as three equally overlapping circles, and has been argued as being the best and most "well-balanced" way of understanding sustainability[185], by giving "equal weight to all three aspects" (see Fig. 1 B)

Fig. 1

A) Neo-classical Economic Picture



B) Conventional Sustainability Picture



A) adapted from Daly, 1997, p6 and B) from Friedman, 2007, p7

This, however, is not a significant enough improvement on the neo-classical picture since the structural relationship between the three domains is unclear. It gives no sense as to how each might be dependent on the other, to potential conflicts between concerns of each and what it would mean to give each "equal weight". Scott-Cato has similarly criticised this as representing another "conventional economic view of the interaction between economy, society and the environment"[186], noting that here the domains "interact but are not interdependent". Indeed, Scott-Cato argues that the conventional picture of sustainability "makes clear why economists refer to the negative consequences of production processes… as an 'externality', because in their view of the world what happens to the environment and the people who live in it happens somewhere else. It can be pushed outside the 'economy' circle and dealt with elsewhere". Although this is more pronounced in the conventional economic picture suggested by Daly and here there is some overlap, it still appears that the domains are largely separated from one another. Conversely, from an environmental economist's perspective, in the conventional sustainability picture the

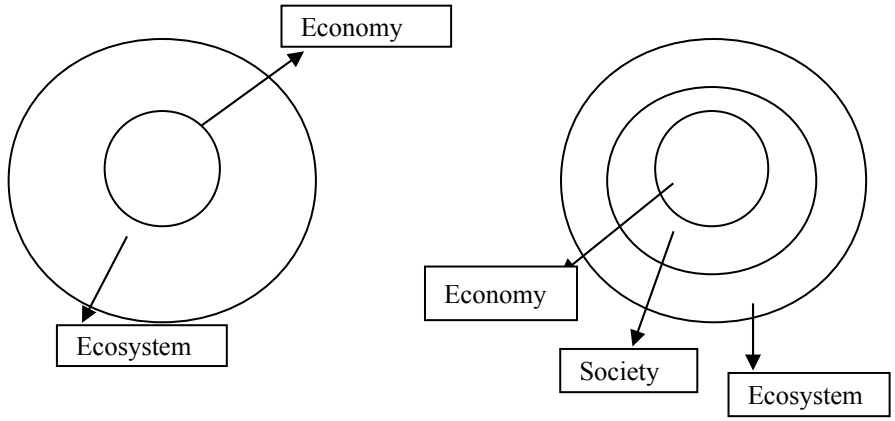
[184] Indeed, Scott-Cato describes this as the "conventional economic view of the interaction between economy, society and environment", Scott-Cato, 2009, p37.
[185] Friedman, 2007, p7
[186] Scott-Cato, 2009, p37.

economic circle could potentially expand infinitely, accommodating and internalising increasing areas of the other two domains.

At the heart of the alternative Green Economic paradigm is a very different picture of the relationship between the environmental, social and economic domains. This shift in conceptualisation is an central part of what it means to move to an alternative paradigm in this context. For Herman Daly, the appropriate "pre-analytic vision" of the economy-environment relationship is of the "economy as subsystem"[187] (see fig.2, A) – a subsystem of the environment, which is itself understood as "ecosystem" to reflect the way in which it functions as a series of interrelated systems, rather than a static collection of resources. The economy is then understood as "not exempt from natural laws"[188] which impose limits on the rate at which production can be undertaken and total economic growth. This is in contrast both to seeing the economy as infinitely expandable in relation to the ecosystem and also to an "ecological reductionism" where human values are understood wholly by "the same evolutionary forces of chance and necessity that presumably control the natural world."[189] The human economy is a distinctive system contained within – part of - the ecosystem.

Fig. 2:

A)Ecological Economic picture ***B)Green Economic picture***



Picture A adapted from Daly, 1997, p49, Picture B from Scott-Cato, 2009, p37

It should also be noted that the limits that constrain the size of the economy relative to the ecosystem are not just absolute physical limits – before we reach this point, there will be

[187] Daly, 1997, p6.
[188] Daly, 1997, p11
[189] Ibid.

different degrees of tolerability in terms of how we and our economy can live. That is, "the maximum scale is not likely to be the optimal scale"[190]. These tolerability limits need to be considered ethically, as I discuss later in 5.2. Additionally, these boundaries should not simply be considered as defining limits or constraints but possibilities; those possibilities offered by the ecosystem for economic activity. For, it should be recalled, the picture aims to convey the idea of dependency of the economy through its embeddedness in the ecosystem. The latter does not prevent the former from further developing in a wholly negative sense, therefore, but rather it provides a constrained set of possibilities for economic activity (beyond which further economic expansion initially diminishes quality of life or ecosystemic functioning and ultimately becomes physically impossible). These limits might best be described as 'constrained possibilities'[191].

What is clearly missing from this description of alternative picture is an explicit mention of society as an additional domain, which, I suggest, reflects the ecological rather than green economic focus of Daly's approach[192]. Green economist Scott-Cato has described a slightly varied picture (see Fig 2, B) which sees the economy as a subsystem embedded in both society and the environment, to reflect an understanding of the economy as limited by, unexhaustive of and formed by, social interactions[193]. That it is "formed by" society is important, since the content and qualities our of economic interactions are forged from our social norms and relationships – Scott-Cato is clear that embedding the economy within society is a call for "a humanizing of economic relationships", rather than operating merely as "production and consumption units"[194], i.e. the notion of "homo economicus", as described earlier by Daly and Cobb[195]. As with the embedding of the economy within the ecosystem, then, the embedding is both positive and negative, reflecting possibilities as well as limits.

[190] Daly, 1997, p51,
[191] I owe this suggestion to Dr Tom Greaves (personal conversation).
[192] The distinction between ecological and green economics is otherwise not yet well-defined. Scott-Cato (Scott-Cato, 2009), describes it as partly methodological, in that ecological economics , like environmental economics "still places considerable emphasis on measurement and valuation, and considers itself a scientific discipline, drawing many concepts and techniques from mainstream economics." (p7) whereas "green economists have a different orientation" and have "taken much from the work of other areas of heterodox economics, particularly ecofeminist and ecosocialist economists, as well as development economists.... When green economists do engage in measurement they try to do it in a more human and accessible way" (p8). Green economics might therefore be understood as having a more explicitly *political*-economic mandate.
[193] Scott-Cato, 2009, p41-45
[194] Scott Cato, 2009, p42
[195] Daly and Cobb, 1990, p85

The Green Economic picture, therefore, understands two of the domains as embedded in, or part of, another; that "economic activity takes place within a network of social relationships"[196], a "subsystem of human society… which is itself, in the second instance, a subsystem of the totality of life on Earth (the biosphere). And no subsystem can expand beyond the capacity of the total system of which it is a part"[197]. This better captures the green economic concern with both social and environmental considerations for economic activity alike. As with the previous Ecological Economic picture, we can describe each subsystem as dependent on and limited by the constrained possibilities offered by the system within which it is embedded.

What I have termed the 'Green Economic picture' is criticised in Friedman[198] for supposedly regarding "nature and natural resources as encompassing and influencing decisions in other realms", thereby enlarging the environmental realm "at the expense of others"[199]. But Friedman and advocates of this conventional view of sustainability ignore the fundamental function of the picture – in Green and Ecological Economics the economy is depicted as a subsystem of the ecosystem because it is understood as part of it, and dependent on it; not because it is seen as crudely less important. Friedman's simplistic idea of importance implies commensurability between the spheres in order to make the comparison between two apparently competing areas of preference, but fails to recognise the nature of the relationship between them.

A further improvement to the Green Economic picture of the three concentric circles which would offer a clearer, more nuanced representation of the Green Economic position, might be to consider variances in their size and shape. With regards to the former, it seems clear that ecosystemic constraints and possibilities for human and non-human life may vary significantly as the ecosystem changes. For example, at times when the earth has been significantly cooler or significantly hotter, the constraints on possibilities for life would be much higher. This might be represented by reducing (or, at other times enlarging - see fig. 3) the outer circle as the total boundary of the ecosystem. This might also alter as a result of human social or economic activity 'from within' the inner two circles. This could help

[196] Scott-Cato, 2009, p37
[197] Porrit, cited in Scott-Cato, p37
[198] Though here the picture is said to represent "environmentalism" – tellingly misconstruing the position as an arbitrary promotion of the "environment" rather than an attempt to understand our relationships with our "ecosystem".
[199] Friedman, 2007, p7.

describe the current concerns with DACC, where, for example, human activity in increasing GHG emissions is altering the function of the climatic process of our ecosystem such that at some point possibilities for life are, overall, reduced, again represented by diminishing the outer circle.

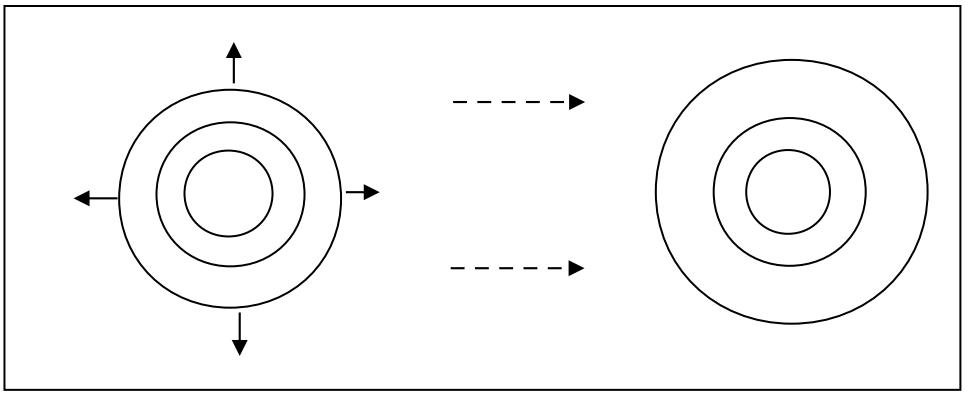


Fig. 3: Changes to the size of ecological constrained possibilities

Similarly, it might then seem reasonable to alter the depiction of the embedded boundaries of the ecosystem and the society and economy subsystems from circles to irregular areas (see fig 4), so as to recognise that constrained possibilities may be expanded for some forms of life or human activities but reduced for others. For example, again regarding the outer ecosystemic boundary, some ecosystemic changes such as in temperature may allow some life forms to flourish but mean others struggle.

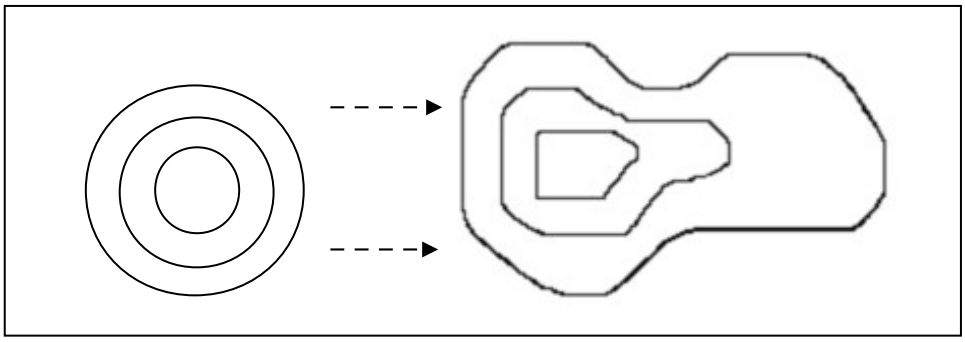


Fig. 4 Changes to the shape of ecological constrained possibilities

These dynamics should be recognised as features of the green economic picture so as to reflect the non-static nature of the processes involved and the interdependencies between them. For such changes are a feature of the very problem we are seeking to describe and resolve in DACC. However, for simplicity's sake, I will continue to represent and refer to

this picture in the more abstracted form of embedded circles, but with the caveat that both size and shape of the boundaries are variable and non-static[200].

5.2 Implications for the criteria for climate policy

The three criteria for a DACC agreement; ecological effectiveness, equity and efficiency, can be understood as mapping onto these three domains. For they reflect a normative recognition of constraints and guidance for economic activity that arise from these domains – i.e. ecological effectiveness as an ecosystemic constraint, equity as a social constraint and efficiency as an economic constraint. The picture described in 2.1 is therefore the conceptual basis for ordering the criteria. The Green Economic paradigm will accordingly order the criteria with ecological effectiveness first, equity second and efficiency third, because each is subject to the constraints of and possibilities afforded by the earlier criterion. In this sense the criteria are not 'prioritised' as such, in terms of one trumping another in order to deal with potential conflicts between them. Rather, they might be understood as being 'ordered' such that each is understood in terms of those prior, and conflicts between them can be resolved.

In fact, when Aubrey Meyer describes the "prioritizing" of his four priorities (from which this thesis was provoked), he does not appear to consider their ordering to be exclusively one of priority[201], but regarding the structural relationship between them. He says, for example, of his first priority, precaution[202], that the "first crucial division of oneness is into two-ness [i.e. equity]", and of his second priority, equity, that this "does not displace but *does contain* and does take precedence over… threeness [i.e. efficiency]"[203]. Whilst the creative language is somewhat obscure and philosophically ambiguous, it seems clear that Meyer's idea is at least in part that each "priority" should be understood and treated in terms of, as part of, those preceding it. For Meyer it is only in so doing that "prosperity", his fourth priority will be attained – each comes from and depends on the previous, which he makes clear by citing his inspiration:

[200] However, these diagrams should not be taken as spatially literal. They aim to conceptually represent the fact that the functioning of the ecosystem can change. But the diagramatic representations of all three spheres should not be understood as implying that all three could literally be captured on one scale such that their relative size and shape could be measured, i.e. strong commensurability.
[201] Although it is *also* this – I return this question of prioritisation later.
[202] Which very roughly performs the function of my "ecological effectiveness" criterion
[203] Meyer, 2000, p33, my emphasis.

> "The simple timeless device of the Tao – 'from one comes two, from two comes three and from three come the ten thousand things' – creates an 'architecture of understanding' for what are otherwise the random and conflicting priorities…"[204]

This becomes slightly less obscure if we understand this as akin to Jonathan Porritt's attempt to reconcile two "potentially irreconcilable imperatives"[205] – the "biological imperative" and the "political imperative". He views the former as an "absolute" imperative to "live sustainably on the planet" if we are to avoid extinction, and the latter as a "relative" imperative "to aspire to improve our material standard of living year on year"[206]. However, such "social and economic goals" are "secondary goals: all else is conditional upon learning to live sustainably within the Earth's systems and limits". By this he means that such "biophysical sustainability" is "*pre-conditional*"[207] to the success of social and economic goals, not that these are of lesser moral importance.

Porritt does point out that "they are really two sides of the same coin"[208]. That is, there is also a sense in which achieving this "biological imperative" might also be said to be dependent on achieving social and economic goals because, for example, poverty and inequality creates pressures for growth which in turn impacts on environmental processes. One might then be tempted to say that equity is also "preconditional" for achieving ecological effectiveness, and question the suggested ordering. However, this sense in which equity might be described as "preconditional" is different. To return to the Green Economic picture, what this signifies is that human social and economic interactions can influence and alter the outer ecosystemic sphere that contains us, from the inside (as discussed at the end of 5.1). But our very existence within which equity becomes relevant is the constrained possibilities created by the ecosystem and how it changes. Ecological effectiveness, like Porritt's "biophysical sustainability" is then "preconditional" in the sense that, although clearly alterable by human economic activity (which is the basis for

[204] Ibid.
[205] Porritt, 2007, p1
[206] Although one could contest this statement of the political imperative and prefer, for example to better distribute what we currently have and regard continuous material improvement to our standard of living to be unnecessary above a certain point, as I suggest in chapter 3, section 4.5.
[207] Porritt, 2007, p8, my emphasis.
[208] Porritt, 2007, p8.

this very discussion), its fulfilment creates or maintains these conditions for our social and economic existence – these particular constrained possibilities.

Similarly, both ecological effectiveness and equity are preconditional to efficiency, since, as I argue in chapter 4, efficiency cannot be understood in isolation. Rather, one has to be efficient *at* something, and it is misleading to speak of an economy as efficient without reference to important ecological and social ends. Hence Scott-Cato has argued that "It is hard to consider as 'efficient' a system which allows some people to starve while others are so over-endowed with resources that they consume so much as to make themselves unhealthy..."[209]. I develop this idea further in chapter 4.

The ordering is in part, then, a structural one. This is also evident in Daly's related description of three conflicting general values for economic activity: allocation (efficiency), distribution (justice) and scale (sustainability)[210], which broadly correspond to the three criteria of efficiency, equity and ecological effectiveness. As Daly implies, it is only once a limit to scale and 'natural capital'[211] is recognised that the relevance of distribution (and therefore equity) can be understood. For, the neo-classical view does not understand economic activity as sharing a "global pie" but "a lot of separate tarts, which some statistician has stupidly aggregated into an abstract pie. The tarts are the product of value added by the labor and capital of the nations that produced them…" whereas once "nature's value added" really is understood as "a global pie... the demands for justice regarding its division and stewardship cannot be subsumed under the traditional notion that value belongs to whoever adds it."[212].

However, the ordering clearly also in this sense has an ethical constituent, and I consider the three ordered criteria to be *ethico-conceptual*. For, as I discussed in 2.1. with regards to the relationship between the embedded spheres, they do not just describe absolute constraints in a lawlike fashion. They are also normative, in that they reflect an ethical judgement about the appropriate level of prevention of problems that would result as

[209] Scott-Cato, 1999, p41
[210] Daly, 1997, p51.
[211] I have some concerns about this terminology which seems to revert to a neo-classical conceptual scheme. However, what is meant is the resource base for our economy – those aspects of capital, the material goods and services required for economic production, which arise from and are limited by 'nature' – the ecosystem.
[212] Daly, 1997, p70. Galbraith has made a similar point (see start of chapter 3).

absolute limits are approached. For, again, the conditions for bare survival are different from conditions for flourishing.

Firstly, they involve minimally ethical judgements, in that given the green economic conceptual understanding of the relationships between the ecosystemic, social and economic domains, most conventional ethical approaches would advocate the general, 'thin' ordering. The general ordering itself does not require or imply that ethical priority be given to non-human nature, or even that it is valued non-instrumentally. The ordering of "ecological effectiveness" as prior to "equity" and "efficiency" requires, as a minimum, only belief in the value of human life and well-being or flourishing – a degree of existence above mere survival – the conditions of which must be preserved through the 'ecological effectiveness' of an international agreement on DACC.

The ethical commitment required for the ordering of "equity" as prior to "efficiency"[213] has two elements. The first element is a belief that all humans have an equal moral status, and the second an agreement that this implies distributional equity rather than simply fair treatment in procedure as, for example, Nozick does in requiring that fair rules guiding transactions are more relevant than the resulting distribution (see discussion in chapter 3). Those who hold either to this latter view or to some form of preference utilitarianism - which is sometimes said to justify the individualism of the conventional economic paradigm - will not consider that equity should be ordered above efficiency since they will not see it as a moral social norm or constraint to guide economic interaction. I will not rehearse here the traditional arguments against these positions. However, I consider arguments in chapter 3 that may persuade those not in principle concerned about distributive equity but about alleviating poverty and meeting basic human needs (see chapter 3, section 5.2).

Secondly, however, the thin ordering itself is still general in that it does not yet determine the content of each criterion, and hence the possibilities for and constraints on one criterion by each prior. For example, "ecological effectiveness" *could* be understood eco-centrically rather than anthropocentrically[214], as in the minimal conception described above. This may

[213] I.e. for considering equity as a social ends which guides economic activity.
[214] Although, as I argue in chapter 2, part A, section 2, I think it ultimately unnecessary to make the distinction with regards to DACC.

be thought to influence the degree of warming seen to be ethically acceptable – *how* ecologically effective an agreement is required to be - and will in turn affects the size of the "global pie" of emissions within which all countries need to be restricted. And there will be disagreements over the "demands of justice" with regards to interpreting the criterion of equity for distributing this "global pie", and within which the concerns of efficiency must in turn operate. These considerations will not alter the order of the criteria, but they will alter their interpretation. The thin ordering of the criteria, then, as I have elucidated it so far, does not entail controversial ethical commitments or by itself tell us much about which kinds of agreements would be acceptable according to the criteria.

Nonetheless, this ordering emerging from a Green Economic perspective and reconceptualisation of, the embeddedness of human economy and society in the ecosystem does, I believe, in fact influence the content of the criteria, to provide a thicker understanding of the ordering. But further argument is needed for this more controversial ethical approach, which is part of the function of later chapters that discuss each criterion in turn.

In suggesting this ethico-conceptual ordering I do not fall on either side of the "fact-value" distinction debate, and commit to whether or not the thicker ethical aspect of the Green Economic paradigm and its ordering of the criteria are wholly distinct from its conceptual basis. It may be argued, for example, as Callicott has suggested, that there is a "psychological connection" which exists "between the way the world is imagined or conceived and what state of things is held to be good or bad, what ways of behaving are right or wrong, and what responsibilities and obligations we, as moral agents, acknowledge"[215]. Or it may be considered more strongly that no distinction exists altogether. However, I wish to move beyond the fact-value debate and consider both as aspects of ways of seeing the world, and recognise, as Daly has, the importance of the "physical, the social and the moral dimensions of our knowledge" being "integrated into a unified paradigm"[216].

This does not, however, mean that there will not be further disagreements within the paradigm over its "physical", "social" or "moral dimensions", (such as the degree to which

[215] Callicott, 1989, p40
[216] Daly, 1993b, p357

it is eco- or anthropocentric). What follows in subsequent chapters will therefore be an attempt to highlight some of these disagreements as they arise in the three criteria for an agreement on DACC, and flesh out how I suggest that they should be resolved. This is in addition to the arguments above over how the Green Economic conceptualisation will influence the content of the criteria and provide a thicker understanding of the ordering.

To offer a little more concreteness, I will briefly suggest one common example of how the order of the criteria might be understood and implemented with regards to an agreement on DACC. The idea of tradable permits, which have recently become one of the most popular international GHG reduction policies, has been described by Daly with regards to his broadly analogous three goals, as "a beautiful example of the independence and proper relationship among allocation, distribution and scale"[217]. The scale of a particular economic activity with regards to the ecosystem is determined by the total number of permits, these are then distributed according to one's favoured principle of equity, and then traded in order to achieve efficiency[218]. How far this does in fact fulfil the ordered criteria is disputable in that, as I discuss in chapter 4, fulfilment of 'efficiency' through trading permits may yet undermine equity, and ecological effectiveness through altering where emission reductions occur. However, it is a plausible example for the moment, of the way in which the ordered criteria might be said to be fulfilled and operate in practice to guide international policy.

Irrespective of the thicker conception of the criteria, one major significance of their general ordering is the Green Economic reversal of the conventional economic starting point for global emission reduction policies; to tackle DACC in the most economically efficient way. Aubrey Meyer has put this more directly:

> "GCI thought that the truly objective question was, 'how well does the economic system serve people and planet' rather than 'how big can we get the economy to be', we agreed that the economists were asking the wrong question"[219].

[217] Daly, 1997, p52
[218] Which is roughly the approach of Meyer's C & C policy framework. See Meyer, 2000.
[219] Meyer, 2000, p14

This requires relinquishing assumptions about the need for continual economic growth and cost minimisation, a misframing of the problem which, Larry Lohmann has argued, has led to overlooking solutions for DACC. He argues, "there has never been a lack of materials or ingenuity for dealing with climate change… For the world's majority, global warming remains a problem for which they already have the solution; forgoing excessive use of fossil fuels"[220]. But this is obscured, and responsibility is distanced (in the West) onto "future car-hungry Chinese or Indians", as part of a conceptualisation where "overconsumption is the universal human destiny"[221]. The policy question of "trade-off" between the criteria must be based instead, as Daly suggests[222], on "an ethical judgment about the quality of our social relations rather than a willingness-to-pay calculation"[223]. That is, an understanding of human prosperity in terms of development – qualitative improvement – within ecological limits, rather than continuous individual or collective economic growth. In arguing for the thin ordering of the criteria I am suggesting that policies must start by judging the degree of DACC that is ethically and biophysically important to prevent; then, whatever this is, to consider how to do so in a way that is globally distributively equitable, and lastly consider the most efficient means of achieving this equitably shared emissions reduction.

To return momentarily to the idea of "ordering", I argued at the start of 5.2 that under the Green Economic ordering of the criteria I have developed, they are not 'prioritised' as such, but, rather, each is understood in terms of the constraints of those prior. However, as I later alluded to, Meyer seemingly does refer to the order of his parallel "priorities" in part in terms of prioritisation. Might this also be useful here? To return to Meyer's principles, the only place in which the ordering is specifically described as prioritisation is the relationship between his priorities two and three – equity and efficiency. To recall, he said that equity "*does contain* and does take precedence over… threeness [i.e. efficiency]"[224]. I suggest that this occurs because he still conceives of efficiency largely in conventional economic terms, i.e. financial cost-minimisation of emissions reductions**,** as (in allocative efficiency at least) does Daly. I discuss this in chapter 4, section 3.1. But conceived thus, it is still in conflict with and thus *can* be trumped by equity, since it presents an alternative

[220] Lohmann, 2008b, p3
[221] Ibid.
[222] Of what he terms the goals of scale, distribution and allocation, Daly, 1997, p51
[223] Daly, 1997, p55.
[224] Meyer, 2000, p33

rather than complementary mode of distributing resources. Under a Green Economic view, equity (and ecological effectiveness) would clearly be prioritised over such a conception of efficiency, and the ordering understood in part as a relationship of prioritisation. However, as I suggested earlier, it would then be unclear what would be left of this conception of efficiency to implement as a criterion without it undermining the other criteria. My aim in chapter 4 will, therefore, be to consider how far this would be the case, and to begin to reconceptualise efficiency so as to complement the other criteria. The idea of prioritisation would then be unnecessary.

6. Revisiting the commons

I want finally to return to the idea of a global commons and sketch an alternative conception to that of game theory, discussed in section B. Richard Starkey has identified several variations in what can be meant by a commons, which he argues are often conflated. Particularly relevant here is whether a commons should be considered as a resource that is "*commonly-owned"*, (Starkey refers to this as "C1") or "*unowned"*, (referred to as "C2"). Under the former, the resource is a remaining part of the world originally owned by all[225], and under the latter not owned by anyone. Starkey argues that C1 is more philosophically dubious than C2 for "the majority of contemporary philosophers"[226] because of the difficulty in establishing the basis for such original common ownership without invoking religious arguments which view a commons as a gift from God[227].

However, I would suggest that the distinction between C1 and C2 is too literal a view of the relationship between common resources and their users. Rather, one can say that the term "commons" describes a particular practical and moral relationship between users of the land or resource in question. I here draw from Baer, who offers the following definition:

> "any system in which the use of a resource by one party causes harm to another can be used as a commons. Those harmed necessarily have a moral stake in the use or

[225] Starkey, 2008, p14.
[226] Starkey, 2008, p18.
[227] See Starkey, 2008, p14-18

> conservation of the resource, even if they don't have the ability to exploit it in kind and thus to cause a symmetric harm… it is when each party can cause harm to the others that we have a classic commons problem"[228]

This description clearly reflects aspects of the game theoretical conception of a commons; however, I read Baer as reversing the imperative in the relationships between individuals in such a scenario. Each party "*can* cause harm to the others", but if the "moral stake" of those harmed is recognised, each individual cannot see their actions in isolation from the effects they collectively have on all affected by the use of the resource, and instead act with this in mind. Recognising a resource as a commons under the view I am suggesting entails recognising that this implies limits on individuals (even if we may disagree about where exactly those limits lie).

Hence as Baer later argues:

> "in a commons, individuals typically gain much more from their use of the resource than they suffer from the degradation their use causes; thus one can increase one's own well-being by overconsuming and harming the other users… a common resource establishes a moral community. To protect the resource and to protect themselves the parties must grant each other the right to a fair share..."[229]

Crucially, here, a moral community is defined as a community where "Each party can harm or be harmed by the other, and depends on the other's cooperation" - it is a relationship of interdependency. For Baer, it is the very possibility of causing harm in such a way in the case of DACC that creates these obligations. "Because one country's use [of the GHG gas assimilative capacity of the earth] affects all others, the moral community and moral obligations exist whether they are respected or not"[230]. The idea of a global moral community in this sense is distinct from traditional communitarian conceptions of community which would require, for example, that "some values and some attitudes towards moral and political questions are common to most people and serve as a background or framework when the members engage in discourse on their political and

[228] Baer, 2002, p396
[229] Baer, 2002, p397
[230] Baer, 2002, p404

social life"[231] - that is, wider ideological or moral similarity, which are not present at a global level.

Rather, the "moral community" as described by Baer is a community only by virtue of the moral and practical relationships of its members regarding the resource in question. Since, Bayer argues, the "whole world" cannot "obtain... the emissions levels of the industrialized countries" without causing "catastrophic climate change" and "this risk puts a limit on Greenhouse Gas emissions, one can think of the limit as defining the available "environmental space"... the particular environmental space at issue here – the atmosphere – must be brought under common governance; global rules for its use and allocation must be discussed, decided and enforced"[232]. This conception of a commons as a "moral community" held together by "moral obligations" established by the harm each can do to another is, therefore at the heart of Baer's – and my – approach to an international climate change agreement. Here, an agreement should recognise the presence of a carrying capacity for GHG emissions, represented by a global emissions cap to define a global 'budget', and the resulting moral obligations to share its use fairly. And in this way, such an understanding of a global climate commons encapsulates the general ordering of the criteria which I described in 5.2.

What is as yet unclear is, as Baer suggests, the "rules for its use and allocation" which "must be discussed"; in terms of the criteria, how exactly these should be interpreted. This discussion will form chapters 2-4 of the thesis, where I discuss the three criteria in order. As I have suggested, the controversy lies not only in questions of distribution – in one's interpretation of equity and efficiency. For, though we may recognise the existence of a carrying capacity for GHG emissions, this is not in itself a straightforward quantity, but depends on the point at which we believe further damage from DACC would be too detrimental. This, along with how we should deal with risk and uncertainty in the damage that might be caused, is the question for the next chapter, which examines the first criterion: ecological effectiveness.

[231] De Shalit, 1995, p27

[232] Baer, 2002, p393. Although, as described in 2.1. this should not be thought of as a fixed space since it will alter over time, and indeed, our current and future emissions levels will 'contract' the space still further. Additionally, it should be remembered that this is not only a "space" but constrained set of possibilities for human existence and activity. However, the term "environmental space" can still be a useful way to convey the concept of a "carrying capacity" and limits to particular economic activities.

CHAPTER 2 – Ecological Effectiveness.

0. Introduction

I now consider the first criterion for an agreement on DACC, ecological effectiveness, which defines the ecological limits within which human societies should operate. In an international climate change agreement, it will guide the emissions space: the quantity of (capped) global emissions and the emissions trajectory judged to be ecologically effective in preventing DACC[1]. This is in contrast to the practice that has emerged during international negotiations, and agreed in the 2009 Copenhagen Accord, of countries simply tabling individual offers or pledges of reductions, irrespective of the resulting total global reductions[2]. The global emissions 'budget' is thereby effectively defined by these pledges, rather than by common, justifiable goals. As one observer from the WWF has commented, "They say they want 2C, the pledges don't get to 2C. It is like the emperor has no clothes"[3]

For an ecological effectiveness criterion to be operational, it must normatively define these limits to emissions space. It is insufficient to simply require that DACC should be prevented, since, as increasingly noted,[4] ""danger" is a contested term"[5], and requires value judgements to be made. Crucially, therefore, it must be clear about what is meant by "danger", or harm. Harms occur as the earth is increasingly less able to absorb further GHGs from the atmosphere, raising global mean temperature (GMT) through radiative forcing and altering climatic systems. We need, therefore, to judge both the point at which this process causes morally relevant harms, but also how to take account of the uncertainty over the corresponding quantity of global GHG emissions. This will affect the level of emissions judged to be "dangerous" under the criterion, and which need to be prevented. These two dimensions of danger[6], harmful effects and the uncertainty of their occurrence,

[1] Ecological effectiveness will not be limited to climate impacts but other environmental/ ecological impacts and risks that might come from our response to climate change. Although the focus here is on international policy (affecting emissions targets and trajectory), national policies responses would need to consider these wider impacts, including, for example, drives for increased nuclear power as a means to reduce GHG emissions.
[2] Vidal, 2010.
[3] Lou Leonard of WWF, cited in Black, 2010.
[4] E.g. Schneider, 2006, p609; Harvey, 2007a, p2; Smith et al, 2009, p1; Brown, 2002, p226
[5] Lorenzoni 2005, p1388.
[6] See e.g. Harvey, 2007a, p2, Schneider and Lane 2006, p8, drawing from the definition of risk as "probability X consequence". In section B, however, I consider the limits to using risk quantitatively in this fashion in order to respond to potential harms.

are considered in Sections A and B respectively, although, as I shall argue, they are significantly intertwined.

Part A examines the harm dimension of danger. I look at why the question of what counts as morally relevant harms from DACC might be thought to be contentious . What we are intuitively concerned with is preventing harms to the well-being of future generations. What we mean by such harms generally is, and should be, I argue: *undermining the ecological conditions of functioning and flourishing of future generations*. But the varying ways of framing the answer by philosophers, politicians, climate scientists and economists, mean that it can appear less straightforward. We are misled into philosophical/ethical difficulties which in turn weaken our moral imperatives[7]. These imperatives are, I conclude, that we have already passed the point of danger, and our task must now be to reduce emissions as quickly and fairly as possible, aiming to limit the overall level of GMT rise to 1-1.5°C.

Section 1 outlines some of the key sources of disagreement and confusion in talking about harms from DACC. In particular, the question of what constitutes harm is (problematically) treated empirically, as discovering and arbitrating between pre-existing subjective values, interests and beliefs**.** Rather, I argue that what counts as relevant harm can be settled on relatively uncontentious moral grounds. Section 2 considers an apparently more entrenched dispute: how far harms to future generations should be balanced against harms and benefits to current generations. I argue that although an intergenerational equity approach is a significant improvement on the attempts of CBA to 'optimise' benefits over time, it is ultimately misleading as a representation of the asymmetry and directionality of intergenerational moral relationships. Rather, I argue in section 2.4, they should be approached developmentally[8]; by considering how best to evolve the conditions and structures from which future societies will emerge, be able to survive and flourish.

[7] I do not offer a conceptual definition of harm here, i.e. consider explicitly whether harm should be best conceived as well-being in terms of interests, rights, needs, happiness or preferences. Rather, I counter concerns about the moral relevance of different kinds of harms from DACC to different groups and entities, by understanding harm in terms of ecological enabling conditions necessary for *any* conception of well-being.

[8] NB developmental as analogous to e.g. a child's or an ecosystem's development, rather than the neo-liberal idea of economic development.

In part B I consider how uncertainties in relating harmful levels of climate change (indicated through GMT) to anthropogenic emissions should be accommodated in defining ecological effectiveness. Section 3 examines possible responses to uncertainty, and the problems in attempting to define unacceptable or dangerous likelihoods in terms of calculable "expected utilities". This assumes uncertainties can be fully quantified as probabilities, relies on CBA and requires a high-stakes moral gamble. Instead, I consider how the precautionary principle, which can accommodate both probabilities and wider uncertainties, should be formulated to guide DACC policy. This must be understood, I argue, as a moral principle, and not reduced to individual taste or personal 'risk aversion'. Given current understanding of risks and uncertainties in climate science I conclude that precautionary action requires aiming to reduce atmospheric emissions concentrations to levels with insignificant risks of a 1-1.5°C GMT rise, i.e. pre-industrial levels, or as close as possible without risking comparable harms from the action taken.

Part A: Morally relevant harms

1. Why we (shouldn't) disagree about (harms from) Climate Change[9]

1. 1 Causal chain of harm

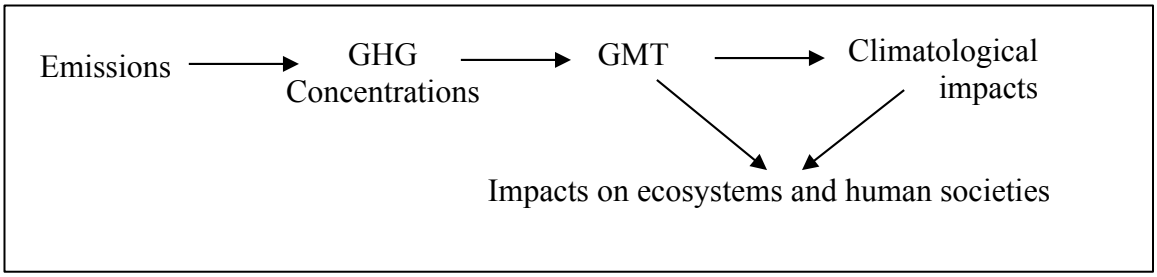
When people refer to threats from DACC, the harms being considered are, not, generally, the emissions levels themselves, but the ultimate effects of these emissions rises[10]. Increased GHG emissions which are not absorbed in planetary sinks lead to increases in the atmospheric concentration of GHGs. Increased concentrations, over time, lead to a rise in GMT through radiative forcing which impacts on human societies and ecological systems, both directly (e.g. through impacting vegetation which flourishes in particular temperature ranges) and indirectly through changes to climatic patterns. Whilst this causal

[9] I allude here to Hulme, 2009; whilst he makes an important contribution to understanding some of the the reasons for disagreement over DACC, my concern is with the relativistic *normative* conclusions he, and some other climate scientists, draw.

[10] Harvey, 2007a, has emphasised the distinction between Dangerous Anthropogenic Interference (DAI) in the climate system – increases in human emissions which may provoke dangerous climatic changes - and Dangerous Climatic Change (DCC) – changes in the climate which may cause "unacceptable harm"(p3). My term "DACC" covers consideration of both, and though both involve dealing with uncertainty, I broadly consider DCC in Part A and DAI in Part B.

chain is vastly simplified[11], and not all harms are mediated by GMT rise, for simplicity, I focus on the effects of GMT[12][13]. This causal chain is summarised in Fig.5. If international limitations on emissions are to be judged "ecologically effective", this arguably requires defining which harmful effects of such rises are morally relevant, working backwards to set limits on the corresponding rise in GMT and ultimately to the emissions levels that would prevent their occurrence.

Fig. 5: The causal chain of harm in DACC



This is not straightforward, since considerable scientific uncertainties exist over what the corresponding emissions levels are, which impacts would occur at particular GMT increases[14], and the complex feedbacks between them (see appendix 2, Fig.7). Although such an approach (i.e. of working backwards through the causal chain[15]) is broadly right, the uncertain nature of the relationships means that we cannot define a particular point at which emissions levels become dangerous, and it should instead be understood in terms of

[11] It does not include feedbacks, discussed in appendix 2.

[12] For example, it has also been noted that GHG concentrations have a direct effect on ecosystems e.g. through increased CO2 absorption altering the PH of the oceans, destabilising marine life (Harvey, 2007a, p2-3), and that this in turn can alter the climate.

[13] Any comprehensive consideration of harms should also take account of more Lenton's recent concerns that "Global average warming is not the only kind of climate change that is dangerous, and long-lived greenhouse gases are not the only cause of dangerous climate change." (Lenton, 2011a, p7). E.g. different atmospheric aerosol distributions can cause "localised warming" which "cannot be meaningfully linked to global temperature"(Lenton, 2011b, p456 and 2011a, p7). This and other kinds of effect risk crossing tipping points in the locality (e.g. ice-sheet loss which could cause massive feedbacks, or changes to monsoons). Lenton (2011b, p454) accordingly advises that danger metrics should include different regional warming, "spatial gradients", and the *rate* of climatic change (e.g. per decade). The latter used to feature in discussions of danger from DACC, since it affects the ability of ecosystems to adapt to warming, but since the mid 1990s research has focused more on the effects of total GMT change. (Randalls, 2010, p600-601).

[14] There is considerable uncertainty as to how particular ecological or social systems will be impacted by particular GMT rises – in part because of uncertainties over regional temperature shifts, climatological responses, and the capacity for adaptation of non-human and human systems. Socio-economic structures and inequalities can make some groups more vulnerable to harm than others. For example, hurricane Katrina in 2005 was found to disproportionately affect African Americans and socially isolated elderly people in New Orleans (Sharkey, 2007). Clearly, as highlighted in the Climate Vulnerability Monitor report (DARA, 2010, p16), inequalities should themselves be challenged and held partly to blame for the resulting harms, but neither can they be ignored when defining the range of effects of DACC, particularly when climate impacts also in turn "wears down progress towards the Millennium development Goals".

[15] See e.g. Harvey 2007a, who takes this approach.

precaution, and ensuring a resilient climate system. But this is considered in part B. What I consider first is which harms we should classify as morally relevant, unacceptable harms that an international agreement should seek to prevent, and why this might involve contention. My argument is that there are no *justifiable* points of contention regarding which harms are relevant which would be significant enough to alter which GMT rise should be considered "dangerous". For, whilst different value judgements can be made, approaching this question ethically rather than accepting all possible judgements as fixed can undermine much contention and ambiguity about the definition of climate 'danger'. This contention can, on a political level, serve to justify failure to agree to more stringent, legally binding global targets.

In a broad sense, harms from DACC that we are seeking to prevent are to the well-being of future generations[16]. The concern is that harmful impacts to well-being may be valued differently. That is, different kinds of harm may occur in different degrees to different groups, entities and processes, and it is contestable which should be taken into consideration. And, if different temperature rises result in different kinds of impacts, it also seems to be contestable which temperature rises - and international emissions levels - are dangerous.

As such, a range of approaches to categorising and measuring DACC impacts have been developed[17]. Most renowned as a tool for such judgements is Smith et al's "burning embers" diagram which appeared first in the IPPC's TAR, and has since been revised[18]. They present five broad "reasons for concern" about DACC: "risks to unique and threatened systems", "risk of extreme weather events", "distribution of impacts", "aggregate impacts" and "risks of large scale discontinuities". Each category of impact is plotted against temperature rise in a coloured bar according to a combination of possible increasingly severe impacts and the increased likelihood of their occurrence. As the authors highlight, it is not an exact science, and the colour changes that represent different

[16] Which includes some people alive today.
[17] Schneider and Lane, 2006, p4, Oppenheimer, 2005, p1399-1400. The IPCC's fourth report also describes "key vulnerabilities" which would be affected by climatic change, so as "to provide guidance to decision-makers for identifying levels and rates of climate change that may be associated with 'dangerous anthropogenic interference' (DAI) with the climate system" (IPCC, 2007c, section 19.1.1).
[18] Smith et al, 2009. These revisions have, in all "reasons for concern", lowered the temperature at which more severe risks occur.

severity levels are accordingly blurred, but it aims to give an indication of the increased risks of different kinds of threats for half degree rises in temperature.

Similarly, Schneider has argued for "five numaires", representing the range of impacts per ton of carbon: market impact (measured in dollars), human lives lost, biodiversity loss (measured in numbers of species lost), distributional impacts (measured in income redistribution) and quality of life (measured in terms of "loss of heritage sites, forced migration, disturbed cultural amenities, etc.")[19].

The problem is (setting aside empirical questions about correctness) that these are still seen as highly contentious in some quarters because the inclusion of any or all of these metrics as relevant "reasons for concern" requires a value-judgement which may be contested[20]. This is in part because of debates over what constitutes a person's well-being (and accordingly when and how it can be harmed), but also from contention over which harmed entities should be morally taken into account (e.g. groups of humans, and the relevance of non-humans), and this latter is the larger part of my focus in section A. In general, my position is that whilst the need for value-judgements rather than scientific investigation per se might understandably make climate scientists hesitant about making claims one way or another, the kind of value-judgement required is less ethically controversial than it is normally judged to be.

1.2 Defining danger: philosophy versus social science

It is worth firstly reflecting on what kinds of questions these are and what kinds of answers can be expected. Climate scientists increasingly point to the limit of climate science in determining policy on DACC, because of the need to form such judgements[21]. However, in most cases, they turn to the social sciences for answers, rather than philosophy or ethics through moral argument, and tend to assume that all perspectives must be taken into account in formulating an answer. Lorenzoni, for example, argues that "we need to

[19] Schneider, 2006, p634.
[20] Some authors of the forthcoming IPCC fifth report have indicated a general institutional reluctance to include them in assessments which might be contested by different governments, although this is anecdotal and I have been unable to locate concerns expressed in writing.
[21] E.g Oppenheimer, 2005, p1399, and most recently, Hulme, 2009, passim, in addition to those listed in footnote 4.

determine what values society will bring to bear in making a judgment of unacceptable or intolerable climate risk as part of the wider question of society deciding what to do"[22]. Oppenheimer argues that in addition to "natural science… Social science may also make important contributions by helping policymakers understand the way in which values arising from cultural and ethical considerations ought to contribute to determining the final outcome"[23].

Similarly, Dessai et al lament the lack of a "universally established methodology or process for deciding what constitutes a dangerous level of climate change, and for whom"[24]. They criticise the inadequacy of "external" definitions of danger in "top down" approaches, where economic and scientific "experts" make use of "physical measures" and "system characteristics of the human or non-human world". They argue that "internal" definitions of danger are also required to make sense of danger as a phenomenon that is also necessarily experienced, and experienced differently by different groups and individuals. However, whilst there may be such a role for researching "internal" definitions, and recognising the "socially constructed" origin of different interpretations of danger, the value debate at an ethical level (i.e. about the content of values themselves) is wholly ignored. Dessai et al assume that it is at the "bottom up" level that issues of value primarily feature, considering "moral" alongside other inputs which are already 'given', including "psychological, social… institutional and cultural processes that influence perceptions of individuals and societies about what constitutes danger and significant impact"[25]. For Dessai et al, and for Lorenzoni, it is social sciences which, it is supposed, should supplement climate science to influence policy by researching the various perspectives on danger which are held and finding out what people *do* value. But such a perspective relies on a relativist understanding of values, construed as equally validly held by different cultures or individuals. Those venturing outside of climate science seem largely to be entrenched in postmodern narratives.

This is exemplified most clearly in Hulme's approach to disagreements on DACC[26]. He argues, for example, that "One of the reasons we disagree about climate change is because

[22] Lorenzoni et al, 2005, p1388.
[23] Oppenheimer, 2005 p1406
[24] Dessai et al, 2004, p12-13
[25] Dessai et al, 2004, p14.
[26] Hulme, 2009.

we believe different things about our duty to others, to Nature and to our deities"[27], but he sees these ethical beliefs relativistically, arguing that "it is one thing to recognise the inescapable ethical character of climate change debates. Quite another is to find ways of reconciling what can be apparently contradictory ethical stances..."[28]. This value-neutral relativist approach is problematic[29]. It is only informative of how people happen to think, and focuses on the perspectives and interests of current rather than future people who may not consider the needs of future people or of non-humans, or understand the processes involved in DACC. If attempts to define values such as danger are to influence policy and play a *normative* role, it is not enough to survey how people currently think about danger and seek simply to 'reconcile' different beliefs. We need to debate explicitly how 'danger' *should* be conceived, and consider what is morally relevant, i.e. the content of such values[30]. This is fundamentally a question for ethics, as Schneider has also recognised[31], and is where philosophy can make a distinctive contribution[32].

1.3. Contentions over morally relevant harms.

How, firstly, *should* we deal with contentions about how well-being is constituted and when it has been harmed? My suggestion is that, even in so far as there are different (e.g. cultural) perspectives on harm that arise from different conceptions of well-being[33], they are all subject to common ecological enabling conditions. That is, that if the ecosystemic processes which our society(ies) are a part of and dependent on are damaged and can no longer sustain us, our various conceptions of the good, of well-being are also harmed. And it is harms at this level – which undercut the various relative conceptions of harm to well-being – that we are concerned with from DACC. Relativity does not extend to this more fundamental level, even if this is not formally recognised by different perspectives. If we care about the value of human life, even if we disagree about certain aspects of its content, therefore, any harms to these ecological enabling conditions from DACC are morally

[27]Hulme, 2009, p144
[28] Hulme, 2009, p174
[29] To emphasise, this is not to suggest that there is no role for such research – it is crucial to look at in terms of climate change communication and awareness, and to encourage involvement in debates as to what action should be taken. The point is that the prescriptive values and proposed actions themselves should not be determined by such research.
[30] I consider a similar problem with climate policy literature's treatment of equity in chapter 3.
[31] Schneider, 2006, p635.
[32] This is not to suggest that 'ordinary people' should be excluded from the decision, rather that the answers cannot be adjudicated through surveying them, but through debate about principles.
[33] I.e. even if *some* form of moral relativism is accepted.

relevant[34]. We can and should then, agree that the "dangerous" level of climate change is that which harms these conditions by damaging ecosystems.

What climate scientists sometimes seem to be concerned with, however, is that whilst in general rising GMT involves global climate instability, particular effects will differ at local levels. That, where a particular level of DACC seems to imply harms to only some regions, or even benefits to others, the moral relevance of such harms is necessarily controversial, since it will harm different people and their ecological enabling conditions[35]. How can we then classify harmful effects as morally relevant for *global* definitions of "dangerous" climate change? But this kind of worry seems to assume that danger is defined on the basis of regional or national self-interest, i.e. a particular level of DACC is defined as harmful/dangerous if and only if one's own group or region suffers harms from it. But this does not seem to define a moral position, rather another assumption about how countries in international negotiations are operating, or about the immediate preoccupations or awareness of people within those countries.

For, even if different levels of DACC will harm different groups, the kinds of harms affecting (say) group A do not simply affect the views of morally relevant harms of group A, but can and should be of moral concern to groups B, C and D, even if they are not likely to suffer themselves. This is a basic premise of moral reasoning – that it moves beyond immediate self-interest. And most ethical systems stress the equal moral worth of human beings, suggesting that harmful effects to even localised ecological conditions of well-being of *any* group that result from DACC, even if they only affect that group, should still be considered to indicate a dangerous level of DACC.

Of course, the argument may be further that at some levels of climate change, there may be some temporary benefits to some regions, and that these need to be weighed against costs to other regions. Whilst it would seem unjustifiable for some to benefit from the suffering of others (e.g. milder weather in already wealthy countries like the UK), the concern could be that some of the benefits prevent people from being harmed themselves. For example,

[34] This in turn will restrict the kinds of well-being/conceptions of the good that are possible, and affect their content, since only those that are compatible with the preservation of these ecological enabling conditions are then morally justifiable.

[35] NB whilst this is not explicit or obviously present in the literature, it is implied in presentations and conversations, anecdotally.

people in Siberia may survive better in a more temperate climate. It starts to look like damage to the ecological conditions of some may not be self-evidently morally relevant if the ecological conditions of others are simultaneously improved.

However, this is dubious reasoning on several counts. Firstly, even if there were some narrow range of GMT rise that caused climate benefits for some areas, there is no reason to think that the climate could be fine-tuned to stay within this 'beneficial' range. The presence of tipping points, nonlinearities and other features of uncertainty in our climate system give no reason to think that it could be maintained at an "optimal" level[36] for some parts of the world. Secondly, it is uncertain as to how far any group would in fact benefit. Spash, for example, argues that "while benefits will accrue to some members of the current generation these are transitory and should not be overemphasised or unqualified", highlighting reasons for doubting the extent of, for example, the "fertilisation effect" of increased CO_2 levels, said to improve crop yields in some areas[37]. Furthermore, the benefits that may occur in some regions with some small increases in GMT are of a certain kind only. Those regions are also still likely to suffer from increasing extreme and chaotic weather[38] (the second "reason for concern"). For example, whilst the IPCC reports that in East and South-Asia, "crop yields could increase up to 20%", it also states that "heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding". The combined risks from flooding and droughts mean that "Endemic morbidity and mortality due to diarrhoeal disease... are expected to rise"[39]. Similarly, whilst in Europe "most negative impacts" will occur "in the south and east" and northern areas are likely to experience *some* benefits, "e.g., increased forest area, increased crop yield"[40], the north will also be at increased risk from "increased coastal erosion and flooding", and "greater winter storm risks"[41].

Relatedly, (and even if one is not a universalist about moral worth as suggested earlier[42]), the idea that direct harms to some regions from global warming would not also affect the well-being of people in other regions is spurious, given the interconnectedness of societies.

[36] See appendix 2.
[37] Spash, 2005, p72
[38] IPCC, 2007a, section 3.2.2
[39] IPCC, 2007c, *Summary for Policymakers*, Section C, Asia.
[40] IPCC, 2007c, Section 12.7
[41] IPCC, 2007c, Section 12.4
[42] I am, and think we should be, universalist about moral worth, but my point is that even those that are not cannot escape the effects of this as a global problem.

In particular, in an increasingly globalised world, where regions are dependent on food supplies and other resources from elsewhere, with economic interdependence and the possibility of migration, it is hard to imagine that harms initially impacting on some areas would not also indirectly affect other areas. Moreover, the phenomenon of DACC is a global one, affecting global conditions. Even if some particular harmful effects were believed to occur to one particular group or region in isolation, they still emerge from levels of DACC and rises in GMT that have other harmful consequences in other areas. In other words, the climate system/biosphere as a whole must be recognised as part of our collective ecological enabling conditions, rather than separate, particular ecosystems.

In light of these arguments, the multi-metric approach should not be seen as trying to combine different competing values or conceptions of harm that different people hold and contest. Rather, it captures a plurality of indicators for harms to the common ecological enabling conditions for well-being. This means that even if different harms to these conditions occur at different levels of global climate change, all should be considered relevant and any level indicating such harm considered dangerous. This suggests that one indicator, the CBA metric, is superfluous. For, if the main task is to determine the point at which ecological damage occurs to the ecological conditions underlying different concepts of well-being, there is no need to resort to CBA as an apparently 'neutral' way of aggregating different harms and benefits to determine when they become relevant.

This is in addition to concerns (about the appropriateness of the reductivism of CBA), which I considered in chapter 1; that important qualitative differences in the kind and level of costs CBA ranges over are ignored, and simply replaced by a new single financial value metric. Interestingly, Schneider and Lane suggest that it is acceptable as part of a "multiple metric" view on harm, and is problematic only when seen as the exclusive measure of harm[43]. But this is unnecessary and inappropriate for inclusion alongside other metrics[44] since it functions rather as an alternative way of assimilating *all* other kinds of harms – a replacement, as I argued in chapter 1, rather than a supplement to other metrics or "reasons for concern".

[43] Schneider and Lane, 2006, p13
[44] Other than perhaps for tactical reasons when seeking to persuade conventional economists who are entirely sceptical of the need for *any* mitigation measures.

One concern might be, however, that whilst I have appealed to ecological enabling conditions rather than the particular content of well-being, these conditions might be harmed in different ways, to different degrees, and perhaps not all of which are morally relevant. To the extent that this is a concern over what constitutes damage to ecosystems, which are non-static systems that can continually evolve and adapt, this seems to be a question for ecologists to determine, as part of the process of understanding and observing ecosystemic functions. However, the concern may be that not all damage to ecosystems will affect humans.

For, what has been said so far seems to present a distinctly anthropocentric ethical view on harm, but what about non-anthropocentric perspectives? For example, damage to vegetation growth in a particular region may be considered harmful by anthropocentric approaches only in so far as it impacts negatively on *human* agricultural production, whereas ecocentric approaches will consider this harmful in itself, if ecosystems and natural processes are of direct moral value. This might cause controversy if, as Donald Brown has argued, the position one holds on this is significant for policy decisions on harm from DACC, and affects the "level of protection from global warming that the world should agree on"[45]. This is because, "different amounts of warming will affect different species of plants and animals"[46].

However, I suggest that if one holds an ecologically sensitive anthropocentrism, the policy outcomes will be not be significantly different[47]. That is, if one's anthropocentrism recognises humans as ecologically located, and recognises our dependence on the ecosystem(s) we are a part of[48], then all ecological harms also pose a threat to humans and their avoidance is in our (fully described) self-interest. For those unconvinced by this, I have offered further arguments in appendix 1, on the grounds both that the theoretical distinction between the approaches is in fact very slim, but also that it is implausible that damage to ecosystems as a whole (as opposed to entities within them) should not harm at

[45] Brown, 2002, p62
[46] Brown, 2002, p61
[47] This does not mean there are no differences between the positions. I suspect, on a personal level, that ecocentric positions are ultimately stronger since they explicitly encourage us to be other regarding, to respect non-human nature directly rather than justify its protection through its usefulness, and can capture many of our moral instincts about non-human nature that are not adequately expressed, I believe, as forms of self-interest (including aesthetic approaches). But my point here is that I don't think this will make any significant difference in climate policy terms, in so far as people *do* hold (ecologically-sensitive) anthropocentric positions.
[48] Which is how Read argues we must conceive ourselves. Read, 2007b, Chapter 1.

least some humans, either directly or indirectly[49]. There may still be concern that some of the ways that humans will be harmed may be through relatively peripheral human activities, which may be considered less morally relevant. However, it is hard to imagine examples that would be genuinely peripheral. For example, the loss of coral reefs may seem to have a less fundamental effect on well-being than, say, the loss of rice paddies; the latter constitutes a major food source for societies that cultivate them, whereas coral reefs may be said to have largely aesthetic value[50], or affect the tourist industry, which could then shift to other areas. However such a view would be exceedingly short-sighted; the wider role that corals play in marine ecosystems may turn out to be extremely important, and in any case signals a wider shift likely to be more generally and fundamentally harmful, in this case, increase in water temperature and ocean acidification; i.e. it is an earlier sign of 'overshoot'[51].

However, these considerations should not affect the main argument here. Brown in any case still concludes that both anthropocentric and non-anthropocentric ethics would recommend an "atmospheric stabilization target" at the "lowest possible level"[52]. The expected inevitable warming from current emissions concentrations[53] means that it is "already very likely too late to prevent damage to ecosystems around the world"[54t], which he suggests an ecocentric ethic would require. And, it should be added, this harm to ecosystems is already seriously affecting humans. For example, the Climate Vulnerability Monitor report has estimated that "climate change is already causing an estimated 350,000 deaths – and more than 10 million cases of illness every year", not predominantly from chaotic weather events, but "climate sensitive disease" such as "malnutrition, diarrheal infections and malaria".[55] Additionally, 2.6 million people per year are estimated to be at risk from "climate-related desertification"[56].

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[49] The reason that anthropocentric approaches seem to differ *substantially* from ecocentric approaches over the harmfulness of DACC, is, as Brown acknowledge, because of taking only certain current human interests into account, using CBA (Brown, 2002, p230). But harmful impacts to ecosystems should be considered even under an anthroprocentric approach, because of their effects on some current and future humans.
[50] Although I personally see nothing peripheral about 'aesthetic' appreciation of non-human nature. If it is understood in a deeper way than merely personal taste; as being about love of, respect for, non-human nature, loss of such phenomena would truly be worthy of grief.
[51] See chapter 1, section 3.1 and appendix 1.
[52] Brown, 2002, p232.
[53] See sections 2.4 and 4 for a brief discussion of warming "in the pipeline".
[54] Brown, 2002, p231.
[55] DARA and Climate Vulnerable Forum, 2010, p13. See thesis Introduction, footnote 3 regarding methodology of the report.
[56] Ibid.

Further warming looks likely to increasingly harm both humans and non-humans. To return to the "burning embers" diagram, the first two "reasons for concern" become severe at just over a 1°C GMT rise – lower than the subsequent three – but relate to both human *and* non-human harms. The first, "Risk to Unique and Threatened Systems", considers damage or irreversible loss to "coral reefs, tropical glaciers, endangered species…" but also to "small island states, and indigenous communities" which are similarly vulnerable to this temperature rise. The second, "Risk of Extreme Weather Events", relates to "increases in extreme events *with substantial consequences for societies and natural systems*"[57], and "includes increase in the frequency, intensity, or consequences of heat waves, floods, droughts, wildfires, or tropical cyclones".

The IPCC's fourth report presents a similar diagram of "key impacts" plotted against "increasing global average temperature change" relative to 1980-1999[58]. Whilst after 1°C GMT change (i.e. around 1.6°C relative to pre-industrial temperatures)[59], it reports significant harms to ecosystems - that 30% of species would be at increasing risk of extinction and that most corals would be bleached, it also reports from 0°C (i.e. any further temperature rise) that coasts face "increased damage from floods and storms", that there are "complex, localised negative impacts on small holders, subsistence farmers and fishers", and "increased morbidity and mortality from heat waves, floods and droughts".

Additionally, more recent work has highlighted that "tipping points" (at which "elements of the Earth's climate system" are tipped "into a different state"[60] and can cause feedbacks) may be reached before GMT rises of 2°C[61]. Lenton[62] has argued that "Estimates of the location of large-scale thresholds... give no particular justification for 2°C above preindustrial as a policy target". Although the latter does "sit within" probability ranges of temperatures at which different tipping points could be crossed, "most recent estimates of the risk of large-scale discontinuities have brought them closer to the present temperature". For example, the studies summarised by Lenton suggest that tipping points in the

[57] Smith et al, 2009, p2, emphasis added.
[58] IPCC, 2007c, *Summary for Policymakers,* section C.15
[59] Lenton states that the IPCC's 1980-1999 reference interval was about "0.6°C above the less accurately known preindustrial level" (Lenton, 2011b, p452).
[60] Lenton, 2011a, p7
[61] Additionally, GMT rise is not the only driver for crossing them - see footnote 13.
[62] Lenton, 2011b, p452

Greenland Ice Sheet could occur between a 1.6-2.6°C GMT rise, and the Arctic summer sea ice between 1.1-2.6°C[63].

It therefore seems reasonable to conclude that we have already reached the point of dangerous climate change, and to agree with Anderson and Bows' suggestion that, given such recent upward revisions of the impacts expected at each GMT rise, it would be "more reasonable to characterise '1°C as the new 2°C'"[64]. In fact, they suggest that, considering the severity of impacts now anticipated at temperature rises above 2°C, it "now more appropriately represents the threshold between dangerous and extremely dangerous climate change"[65].

2. The moral relevance of future harms.

I now turn to a possibly more substantial challenge to identifying morally relevant harms from DACC which should constitute the definition of "danger" in an ecological effectiveness criterion. That is the aspect of futurity: the moral implications of such harms affecting future, rather than current generations. One such significant concern regards the uncertainty over a harm's occurrence, which may be thought to dilute its moral relevance. I deal with this in part B, where I consider the uncertainty/likelihood dimension of danger and our responses to it.

The main concern addressed through section 2, however, is how future harms from DACC should be balanced against harms to current generations from mitigative (preventative) activity, or even against possible benefits from DACC. I do not survey different ways of grounding our obligations to prevent harms to future generations, but focus on how they should be understood in relation to obligations to current generations. In 2.2-2.4 I outline two dominant approaches to this question, and present a third which understands the problem developmentally. Prior to this, however, I would like to deal with a preliminary worry which may seem to undermine this task. This is the suggestion that harming future people is not straightforwardly possible – Parfit's problem of "non-identity".

[63] Ibid.
[64] Anderson and Bows, 2011, p40 (footnote 31)
[65] Anderson and Bows, 2011, p41.

2.1 The problem of non-identity.

Parfit draws attention to the fact that the very existence of future people is contingent on current policy decisions; different people are likely to be born as a result of different decisions[66]. But, he argues, how can future people then be harmed (e.g. in this case, by implementing an ineffective climate change agreement) if those particular individuals who would exist are different to those who would have existed under a different policy choice? Because, Parfit suggests, harming a person involves making things worse *for* that person. We cannot have made things worse for future people if they would otherwise not have existed – different individuals would have lived and experienced the better set of conditions created by the alternative policy. These are "different people choices"[67]. And if no person has been made worse off by the policy, how can it be said to be harmful?

This argument should not be confused with the claim that future people cannot have *any* sorts of rights or claims against us because they do not yet exist. I do not consider this here, since it has been adequately countered elsewhere[68]. The non-identity problem has been dealt with in varying ways: by arguing in favour of consequentialist conceptions of harm which do not depend on particular individuals being made worse off[69], or through other non-comparative accounts of harm, such as Meyer's threshold conception[70]. I will not examine these alternatives here, or consider the non-identity problem in depth. Rather I wish simply to highlight why, in the particular case of DACC at least, non-identity should not be seen as a problem for the view of harm that I have been advocating.

I have identified the relevant harms as being to the ecological conditions for the functioning and flourishing of future generations. We thereby harm future generations when we create conditions in which their ability to survive is compromised. Here we need not understand harm in terms of alterations to the well-being of particular individuals, but to the conditions for well-being of *any* individuals – the conditions under which they will come to exist. The harms we are obliged to prevent from DACC are thereby such that *whoever* will live in this particular society will be less able to survive and flourish under

[66] I.e. because future events are subtly altered over time, and even slight differences in the times people reproduce will combine different spermatozoa and/or ova. Parfit, 1984, p351-355.
[67] Parfit, 1984, p356
[68] See Meyer, 2004, p22-23.
[69] See Broome et al, 1992
[70] See e.g. Meyer, 2004.

the resulting temperature rise (A), than those would live under no (or a substantially lower) temperature rise (B).

This may still sound slightly awkward. The thrust of Parfit's concerns in the non-identity problem is to explain how an act that we intuitively understand as being wrong for a person or persons can be harmful if they are not made worse-off. So the question may persist: if we choose (A), do we then harm those particular people who live as a result? Possibly one could say: yes, if the approach I have just outlined is interpreted as offering something akin to Meyer's threshold conception of harm - a non-comparative view of harm, which would view future people as being harmed if they did not exist in sufficient ecological conditions. Or we might suggest that those particular people are not harmed, if what I have said is interpreted as retaining the comparative view of harm but directed towards the group or community as a whole of the "future generation" rather than the individuals within it.

However, this is the wrong kind of question to ask. For it stems from the way in which we deal with harms intragenerationally, where the moral discourse is more familiar, and attempts to apply this to a very different kind of context – *intergenerational* morality. And this seems to be partially motivating the drive to resolve the Non-Identity Problem. Parfit and others do recognise that the features of intergenerational moral relationships are very different from those with contemporaries – the very purpose of the Non-Identity Problem is to look for the "moral reason"[71] which explains our intuitions if it cannot simply be that particular peoples' lives are made worse in "different people choices". But in seeking to offer such further explanations and search for "theory X" which tell us "which set of principles… we ought to accept"[72] as justifying our intuitions, they are succumbing to the attempt to reduce the former to the latter – to apply the rules from one kind of case to another.

What I am suggesting is that rather than understanding non-identity as a problem to resolve as a special case of our ordinary interactions, this should instead be understood as identifying a defining feature of our moral relations to future generations. That in certain important respects they are not analogous to intragenerational relationships, since we *create* future generations and their conditions, and should not think of them as in any way

[71] Parfit, 1984, p363
[72] Parfit, 1984, p361

already existing at another temporal location[73]. This structure, and our intuitions about how to deal with it, should be seen as constituting a different paradigm case and set of intuitions, which cannot be explained in terms of other more fundamental principles, or a wholesale theory to 'explain' it. It only seems to pose a problem when we try to import inappropriate modes of ethical thinking.

The question then becomes – what kinds of future lives and circumstances should we create? And it seems to me that, in the case of DACC, we at least have an obligation to create lives that exist in ecologically secure communities, and we cause harm when we impair these future conditions[74]. This is central to the main concern which I outlined at the start of section 2, of how far harms to future generations should be balanced against those to current generations. For the main two competing ethical approaches to balancing our obligations to future generations against those to current generations – CBA and intergenerational equity – largely ignore this defining characteristic of intergenerational moral relationships. Whilst, therefore, we must also take account of climate policy impacts on current generations when considering prevention of harm to future generations, both approaches are misleading in the way they do so.

I now consider these two main ethical approaches, which, I argue, inadequately capture our moral instincts and defining moral features of intergenerational relationships in trying to weigh harms to current and future generations from DACC. The first, economic CBA, may seem strange to describe as an ethical approach. But, as suggested in chapter 1, it is committed to a particular set of value judgements which assume that price can and should be used to reflect different costs and benefits to make them commensurable. The second, intergenerational equity, reflects a justice-based metaphor that judges our obligations to future generations in terms of distributional equality between different generations (e.g. of well-being, capabilities or resources). Whilst this does capture something useful and important about the way we ought to think about future generations, it is not exhaustive and as I shall suggest, is misleading if applied in a wholesale way as an ethical theory, since it ignores intergenerational asymmetries.

[73] On the wider disanalogy between time and space, see Read, 2003, p33 and p24 (footnote 1).
[74] This is not to say that we create a whole new set of claims and intuitions – they exist already in the way in which we think about future generations in other contexts – as, e.g our children, which I outline in 2.4

My subsequent approach in 2.4 is not to present an alternative ethical theory. Indeed, a theory as such is unnecessary for guiding actions here[75] – as Donald Brown has argued, most ethical positions can[76] come to the same broad conclusions regarding policy for climate change mitigation[77][78]. Rather, such approaches can be regarded as conceptual metaphors which can aid ethical thinking about the problem in hand. My aim in 2.4. is to highlight moral aspects of our relationship with future generations which are either missed or accommodated only indirectly and in potentially misleading ways in the approaches of 2.2. and 2.3[79]. These should, I suggest, guide our definition of unacceptable harms in DACC and the temperature rises that should be prevented.

2.2. Cost-benefit analysis

Probably the most well known approach to defining our obligations to future generations given impacts on current generations (and therefore 'unacceptable' future harms) is economic CBA. This seeks to trade-off present and future economic costs and benefits of particular levels of GMT rise (or, in terms of mitigation, of reducing to particular global emissions levels). I have already argued in chapter 1 against such an approach generally as a determinant of mitigation levels. My discussion in section 1.3 focused on its use in aggregating intragenerational costs and benefits, but it is also used to trade-off costs and benefits across time to define acceptable or optimal levels of harm between generations. The general criticisms also apply here: of its reductivism and inability to distinguish kinds of harm. This has a particular force in light of the distinction I have drawn attention to in 2.1., between the distinct ways that we can harm future generations and contemporaries. I return to this shortly.

But first, it is worth considering briefly one particular widely criticised CBA feature in this context: the practice of discounting future costs. I will not address this in any detail because it has been adequately countered elsewhere, and is now relatively widely accepted

[75] To say that ethical theory is unnecessary for guiding actions may seem a fairly controversial claim to make, but please see the thesis Introduction, for an outline of my position on the role of theory in ethics.
[76] I.e. they may not; it depends on how they are applied, as I argue next.
[77] Brown, 2002, p232.
[78] This is what should be expected if, as suggested in the thesis Introduction, ethical theories are designed to reach conclusions which match our moral intuitions.
[79] For this reason I do not consider every distinct ethical approach to our obligations to future generations, e.g. forms of utilitarianism other than CBA, rights-based accounts or communitarian approaches (see De Shalit, 1995, for a good overview). Rather I aim to focus on aspects of ethical thinking which have been over or under emphasised, and which should guide the way we think about unacceptable harms in DACC.

as inappropriate (at least regarding DACC). But it is worth highlighting the main concerns, to distinguish them from criticisms of CBA in general. Padilla has argued, for example, that discounting "devalues and practically removes from the analysis the impacts that occur in the distant future in such a way that for these models the maintenance of the necessary conditions of life far in the future is of negligible present value."[80]. He highlights that "conventional models assume that future individuals will be richer"[81], whereas, as Singer has pointed out "a major change in the climate of our planet would have such drastic and widespread effects that we really have no idea what it would do to prices"[82].

And in any case, as Brown argues, whilst discounting makes some sense for investors wanting maximise returns from an investment, when applied to environmental issues, "this technique makes current investors' interests, not future generations' welfare the focus of concern"[83]. Similarly, Broome has partially defended the economic practice of discounting as aiming not to discount the well-being of future generations, but commodities, so as to reflect the values and interests of present generations[84]. But he concludes that this *amounts* to discounting future well-being, and, therefore, that "It is certainly unreliable for evaluating long-term projects that have large effects on future generations" such as "mitigating global warming"[85]. Problematically, then, discounting practices assume the continuation of a functioning economic system, ignoring the relevance of harm to ecological conditions and the insight in 2.1. that the shape of future generations is contingent on current decisions.

In recognising the inadequacy of discounting, we have therefore come a long way from Lomborg's (discounted) economic criticisms of Kyoto[86], to the extent that Stern also felt unable to justify anything other than a negligible discount rate in his 2006 review[87]. However, even if discounting is avoided or reduced to a negligible level, CBA is still a highly problematic method for balancing future and current costs to define unacceptable levels of harm from DACC. It assumes, as Toman has noted, that it is "possible as well as

[80]Padilla, 2004, p527
[81]Padilla, 2004, p528
[82] Singer, 2006, p417
[83] Brown, 2002, p178
[84] Broome, 1994, passim.
[85] Broome, 1994, p156.
[86] Lomborg claimed that the Kyoto protocol would "lead to a net loss of $150 billion", but based this on a discount rate of 5%. Singer, 2006, p417.
[87] Stern 2006, p31. Although Stern was still much criticised in some quarters for his discount rate e.g. from Nordhaus, see Hulme, 2009, p127.

socially acceptable to admit a wide range of tradeoffs between climate change damages and other economic values"[88]. Whereas, as I have suggested, the kind of harms we are concerned with from DACC are to the ecological (pre-) conditions of well-being, and are of a fundamentally different kind to the various different costs of mitigation to current generations. Of course, these are not also all purely "financial" either and may also include harms to well-being in other ways, for example, reductions in standard of living, changes in lifestyle and possibly even fears of economic collapse triggered by sudden and deep restrictions on economic growth. But the ways in which we might weigh these possible harms against one another cannot be straightforwardly captured by a single economic metric. Instead, we need to consider the kinds of impacts these have, which, as Toman has argued, should include "a variety of different kinds of information about climate change risks and policy impacts, including information about physical consequences as well as economic benefits and costs"[89]. I attempt to do this in 2.4.

These criticisms hold even if the costs aimed at fully reflecting ecological impacts were less narrowly anthropocentric, through pricing costs to ecosystems and cost implications for future human societies, for example to health, or agriculture. Whilst such calculations might help make the case for some degree of mitigation for those as yet unpersuaded, they may still under-represent the severity of future harms from DACC, since different costs and benefits are nonetheless assumed to be commensurable. It still assumes, that is, that the costs of these harms should be straightforwardly traded off; against the costs of mitigation to present generations (which may be high for reasons unrelated to their societal importance)[90] and against benefits to some future groups at lower levels of warming to define acceptable, or 'optimal' levels of harm[91].

Stern, for example, attempts to improve on conventional CBA, arguing for it to "be thought of in terms of the expected impacts on well-being over time, appropriately discounted, not simply monetary amounts." to accommodate "risk weighting, risk aversion and considerations of fairness across individuals and generations"[92] His approach gives ethics an unprecedented role in the economic analysis. However, in practice, well-being is

[88] Toman, 2006, p371.
[89] Toman, 2006, p370
[90] That is not to say that they should not be accounted for – rather, they should not be made commensurable in a single-metric calculation, irrespective of the kind of impact at stake.
[91] I discuss similar concerns from Lohmann in section 3.2.
[92] Stern, 2006, p291.

still approximated in his CBA using a social welfare function[93] which commensurates in terms of consumption. Even though this is broadly conceived, it still makes fixed assumptions about, for example "the distribution of consumption across individuals" and the "difference" it should make "if a given loss of consumption opportunities affects a rich person rather than a poor person, or someone today rather than in a hundred years' time"[94], and assumes that such ethical considerations can be aggregated effectively.

Problematically so, since there also remain aspects of well-being which cannot be reflected at all in economic cost (for example, if people die and therefore incur no further medical costs). This ignores, as Brown and many others have pointed out, the widely supported intuition that rights or certain levels of well-being should be protected irrespective of cost[95]:"If persons have duties not to deprive others of life, health, or liberty without their consent, then welfare considerations cannot justify policies that kill people or damage their health"[96] Similarly, Padilla has criticised CBA for misframing the issue in terms of weighing costs for current generations against "benefits" for future generations (i.e. from DACC prevention), whereas, "This is not to 'give' anything to future generations, but rather to stop taking away something to which... they are entitled".[97] Even a more broadly conceived CBA will, therefore, still allow for more severe harms to well-being from DACC to be outweighed by economically costly mitigation measures, even though they will not threaten well-being so fundamentally, by undermining its ecological preconditions. This might be prevented through, for example, assigning infinite financial values to certain kinds of fundamental harm – but then CBA would be superfluous to the process of making the cost-benefit judgements in the first place, since the decision would already be made at the level of assigning financial values[98].

[93] Stern, 2006, p30
[94] Ibid.
[95] Brown, 2002, p171
[96] Brown, 2007
[97] Padilla, 2004, p536
[98] Interestingly, this is exactly the kind of phenomenon evident in Ackerman et al's work on DICE – an Integrated Assessment Model of the costs and benefits on climate change. They acknowledge that it is "known for projecting that the optimal climate policy is one of very gradual abatement" – which would be inadequate to prevent higher temperature rises – and "investigate whether, with slightly different assumptions, DICE might recommend a trajectory that begins abatement much more rapidly, and leads to stabilization at 350 ppm CO_2". That is, they try to change the initial assumptions and parameters in order to produce an outcome that *already* seems preferable (Ackerman et al, 2009, p30).

2.3 Intergenerational equity

However, this should not mislead us into thinking that balancing current and future harms is straightforwardly and predominantly an issue of intergenerational distribution either, which, as I shall suggest, can be problematic. Yet this is the alternate route that is often pursued. Commentators are often keen to counter the CBA approach by turning to concepts of intergenerational equity or justice. Since CBA trades costs to future generations against costs to contemporaries, this second broad approach seeks to emphasise the equal worth of future people and treat our obligations to them as analogous to obligations of distributive justice to others within our current generation[99]. The problem with CBA as applied to intergenerational policy issues is therefore diagnosed as unfair cost-bearing between future and current generations, just as occurs between countries and regions[100].

For example, the Pew Center for climate change describes international equity as "The fairness of the distribution of the costs and benefits of a policy when costs and benefits are borne by different generations"[101]. More explicitly, Page understands it as part of the same "set of questions" for "global distributive justice" vis a vis climate change, i.e. "how benefits and burdens should be distributed *within and between* generations"[102]. Similarly, Anand and Sen argue that our obligations to future generations are "a matter of distributional equity"[103]. Crucially, this conception of intergenerational equity or justice goes beyond a more general concern for intergenerational obligations; "the basic belief", which Anand and Sen also express[104], "that the interests of future generations should receive the same kind of attention that those in the present generation get"[105]. Rather, the concept asserts that such attention be interpreted distributionally, "sharing the capacity for wellbeing between present people and future people in an acceptable way... which neither the present generation nor the future generations can readily reject"[106]

[99] I explore the concept of (intragenerational) equity in DACC in chapter 3.
[100] Although these approaches often seem more narrowly anthropocentric, one can more generously think of intergenerational equity as using human measures as a proxy for wider, ecological harms/ harms to humans *as* situated within ecosystems (i.e. as using ecologically sensitive anthropocentrism).
[101] (Glossary entry): http://www.pewclimate.org/global-warming-basics/full_glossary/glossary.php
[102] Page, 2007, p225, my emphasis.
[103] Anand and Sen, 2000, p2038, discussed in the context of sustainability.
[104] Though they do not recognise it as a distinct claim.
[105] Anand and Sen, 2000, p2030
[106] Anand and Sen, 2000, p2038. Although it should be noted that Anand and Sen seem here to ground the distributive view on a contractual basis. Intergenerational justice can, as Page notes, be justified also through other approaches – he argues - "communitarianism... and impersonal consequentialism" as well as reciprocity (Page, 2007, p226).

Under this view, unacceptable harms to future generations from DACC should, roughly speaking, be determined by ones principle of justice or equity. Page, for example, has examined how our obligations to future generations can be understood according to ones views as to the "currency", "shape" and "scope" of justice[107]; i.e. what it is that should be distributed fairly, whether according to equality, priority or sufficiency, and which people count as relevant for such just distributions. Under this family of approaches, future generations can be understood as unacceptably harmed when the distributive arrangements under ones chosen position are not met[108]. However, I do not consider any of these particular variants here[109], since my focus is to consider limitations of the intergenerational equity metaphor more generally.

Aspects of this approach seem very reasonable. In particular, its grounding in the kind of appeal made by Anand and Sen to the "universalism" of the "shared claim" that all humans have "the basic capability to lead worthwhile lives"[110] highlights the needs and meaningfulness of lives for those living in the future. Our use of resources and interaction with the ecosystem now can diminish their ecological conditions and abilities to meet their needs - can, in this sense, leave them less than we have. This approach can provide a helpful counter to practices of discounting and aggregation of future costs of DACC against current benefits of refraining from mitigation, by framing the relationship in terms of fairness. But the extension of this metaphor – of inter-temporal fairness as strictly analogous to inter-spatial fairness - is problematic.

In part this is a difficulty in the applicability of distributive justice or fairness and the conditions for justice to intergenerational relationships. As Page has highlighted, "The vast majority of future individuals that will benefit from the modest amount of climate change avoided will never be in a position to repay the present generation for their sacrifice"[111] since they will no longer be living. Page calls this the "non-reciprocity problem"[112]. It is a

[107] Page, 2006, p50-51.
[108] Since the aim is to establish the just "profile of benefits and burdens that we should aim for in our dealings with contemporaries and future generations", Page, 2006, p96.
[109] Although I do consider them in chapter 3 in the context of intragenerational equity in sharing the emissions budget/use of the atmospheric commons.
[110] Anand and Sen, 2000, p2030.
[111] Page, 2007, p231
[112] Ibid.

problem, because justice conceived as a mutually beneficial arrangement cannot be applied[113]. For, as Gardiner has described elsewhere, in DACC, "control of the situation rests completely within the current generation"[114]. And since the current generation has already inherited an overpolluted planet, it is not in its (narrowly conceived, at least) self-interest to "cooperate" with future generations – it "will achieve nothing for itself by holding back"[115]. Page argues that the problem can be largely circumvented by some version of an "international stewardship"[116] modification, at least in the case of public goods such as having a "hospitable climate system"[117]. This means, broadly, that we reciprocate to the previous generations for benefits they left us not *directly* to them, but *indirectly* by passing on benefits to future generations[118], so that reciprocity is understood in terms of "fairness" rather than mutual "self-interest"[119].

But this seems problematic for several reasons. Firstly, it means that we have no such intergenerational duties if we have not received certain benefits - Page is explicit, for example, in stipulating that "there can be no duty of fair reciprocity to pass on what one has not received"[120]. To justify the "sacrifices" of current generations in mitigative action against climate change, Page is forced to assume that "members of the present generation have been bequeathed an atmospheric system largely devoid of dangerous impacts"[121]. Whilst rising concentrations will significantly worsen the harms from DACC, the changes to the climate system that we have already inherited, as discussed in sections 1.3 and 4, are such that Page's assumption can no longer be made with confidence. This perspective could worryingly undermine the case for mitigative action, and makes our obligations to future generations oddly dependent on our being 'repaid' by previous generations.

[113] Rights-based accounts share aspects of the intergenerational justice metaphor in this respect. As Jonas, 1985, p38-39 has highlighted, "the traditional idea of rights and duties" is "grounded upon reciprocity, according to which my duty is the counterpart of another's right, which in turn is seen as the like of my own right...". "This scheme fails" in the case of future generations" since the "nonexistent" do not *yet* have rights (until they exist) and cannot have reciprocal duties to us; the rights/duties scheme therefore needs to be significantly revised so as to preclude the possibility of asking the question, "What has the future ever done for me? Does it respect my rights?". There is not space here to consider rights-based accounts further with regards to intergenerational obligations, but any such account but would need to consider how far it can embrace the features of intergenerational relationships that I outline as important in 2.4, and how far it relies on a variant of the intergenerational justice metaphor.
[114] Apart from, that is, where generations overlap, when Gardiner supposes that there is some degree of reciprocity in preserving the advantage of social cooperation. See Gardiner, 2004, p30
[115] Gardiner, 2004, p30.
[116] Page, 2007, p232-238
[117] Page, 2007, p234
[118] Page, 2007, p232-233.
[119] Page, 2007, p227
[120] Page, 2007, p237.
[121] Ibid.

But secondly, it glosses over the fundamentally asymmetrical and non-reciprocal relationship between generations, since it is not then clear that indirect reciprocity should still count as reciprocity at all. And Read has questioned whether it is meaningful to talk about fairness between generations, since "there is no fairness, no genuine equity… between two utter unequals…Such fairness is a standing invitation to bad faith; because there is no actual 'contract' here, no agreement, no negotiation: just whatever you decide 'is' fair."[122]. It might be said that Read's concerns have force only against the procedure *for* rather than the content *of* fairness; that it is precisely in situations of inequality that fairness becomes relevant at all, as a moral norm above and beyond mutual self-interest. However, the intergenerational scenario is unequal in a very particular way; the very existence of one depends entirely on the actions of the other. This goes beyond fairness, and beyond intergenerational distributive justice more generally, howsoever it is theoretically justified, in the following ways.

The intergenerational justice metaphor implies, in the first place, that what is morally required is an evenness in distribution (of goods, or wellbeing) between generations. And, tied to the concern that we have no obligations towards future generations without receiving parallel benefits from previous ones, this risks inviting concerns that in "saving" for a future generation, a previous generation could leave them too much. Indeed, Solow has worryingly put forward such a suggestion, which it is worth reproducing in full[123]:

> "You could make a good case that our ancestors, who were considerably poorer than we are, whose standard of living was considerably less than our own, were probably excessively generous in providing for us. They cut down a lot of trees, but they saved a lot and they built a lot of railroad rights-of-way. Both privately and publicly they probably did better by us than a sort of fair minded judge in thinking about the equity (whether they got their share and we got our share or whether we profited at their expense) would have required. It would have been okay for them to save a little less, to enjoy a little more and give us a little less of a start than our generation has had."

[122] Read, *Forthcoming(a),* p4
[123] Cited (uncritically) in Anand and Sen, 2000, p2035.

This is both conceptually and morally problematic. It is conceptually misleading because by definition the process of learning and development of knowledge and technology means that any resulting improvements to the standard of living to future generations could not meaningfully be said to be distributed more fairly between generations. In terms of the improvements brought by such development[124], future people will necessarily have more or better in some senses than previous generations – this is simply the notion of development. Solow, as a development economist is clearly aware of this[125]. But its implications are overlooked in nonetheless considering this development distributionally, as though between two discrete societies, already existing in different temporal (as opposed to spatial) locations, rather than as a process whereby one emerges from the other. For it is a necessary feature of development that future generations of any functioning society will "profit" at the "expense" of previous generations.

But there is also something morally abhorrent about the idea that we should withhold improvements to human society simply because more of the benefits are experienced by future people. We surely want to improve our societies for the better, to leave future generations a better world than the one we inhabit, to improve their chances of surviving, flourishing and living fulfilling and secure lives. Whereas, as Anand and Sen suggest, the "universalism" in intergenerational distributive equity perspective implies "an obligation to preserve the present-day economic opportunities (such as productive capacity) for the future, not necessarily to *increase* them."[126]. I do not mean to suggest that we *should* increase "economic opportunities", because of the limits to economic growth considered in chapter 1. But given that economic opportunities, for Anand and Sen, stand as a proxy for well-being, the implication is also that there is no obligation to improve well-being.

Rawls, on the other hand, does seem to conceive of his notion of "just savings" in the context of building and improving ones society or civilisation, and criticises those who

[124] This is not to suggest that all development *does* bring improvements, or, where it does, that it always brings uniform improvements to subsequent generations. As has been suggested in chapter 1, this is precisely not the case for much economic growth.
[125] Indeed, he offers a similar criticism of applying a maximin principle to intergenerational relationships, which is unsatisfactory because "the maxi-min criterion is so much at the mercy of initial conditions. If the initial capital stock is very small [following the principle would imply that] no more will be accumulated and the standard of living will be forever low" - i.e. no investments, improvements or savings would ever be made for future generations because current generations, as the worst off, would worsen their position by improving that of those in the future. Solow, 1974, p33
[126] Anand and Sen, 2000, p2035.

have lamented the "chronological unfairness" of this directionality[127]. Indeed, he is clear that the "just savings principle can be regarded as an understanding between generations to carry their fair share of the burden of realizing and preserving a just society... during the whole course of a society's history"[128]. This, then, is a significant improvement. But it is difficult to see why this should be understood in terms of distributive justice - how, if later generations are properly to enjoy a better life than previous ones, it makes sense to talk of the intergenerational "understanding" in terms of a just distribution between generations at all.

This may seem plausible from Rawls' description of the generational burden, (the savings left by one generation for the next), as a "fair equivalent in real capital... in return for what is received from previous generations"[129]. But what he means by a "fair equivalent" is not an economically equivalent quantity (which would, in any case seem odd to require of each generation, with different circumstances and different challenges). It is, in fact, "what is reasonable for members of adjacent generations to expect of one another at each level of advance... balancing how much at each stage they would be willing to save for their immediate descendants against what they would feel entitled to claim of their immediate predecessors"[130], i.e. there is a different "rate... for all stages". This continues until the "last stage at which saving is required", after which sufficient wealth has been accumulated to bring about "the full realization of just institutions and the fair value of liberty".

But this way of understanding intergenerational relations, is worrying. One would need to significantly stretch this metaphor to apply it to DACC, or other environmental crises. For Rawls imagines society like a savings account – where a regular investment over time (in socio-economic infrastructure) can provide regular interest repayments (i.e. the wealth generated from this size of economy) which increase in size until it has accumulated enough for society to live justly and sufficiently from the interest[131]. But, even if we (generously) assume that the savings need not represent accumulation, but a curb on each generation's (rate of) use of natural resources and pollution sinks, it is not clear why the

[127] Rawls, 1972, p291.
[128] Rawls, 1972, p289.
[129] Rawls, 1972, p288, where "capital" is "knowledge and culture... techniques and skills" as well as "factories and machines".
[130] Rawls, 1972, p289
[131] Although , in terms of the economy's size, this latter point is preferable to assuming a need for continuous economic accumulation, which Rawls correctly counters in this section, arguing that "great wealth is not required" for a "just and good society". Rawls, 1972, p190.

process of defining different appropriate savings rates at each stage is best understood as one of "just savings", or fairness. Such a characterisation is worrying, especially when Rawls says (foreshadowing Solow, cited above) that just savings "places an upper bound on how much a generation can be asked to save for the welfare of later generations... Each age is to do its fair share... but beyond this more cannot be required"[132].

For, under Rawls and other approaches to intergenerational equity, the emphasis on "distributive justice" seems a misleading way to consider and define unacceptable harms to future generations from DACC, when what is at stake is the health, development and resilience of our ecosystems, our ecological preconditions, rather than simply a stockpile of a resource being distributed[133]. Even if our "currency of justice" is construed as well-being[134] rather than resources, the metaphor still suggests a distribution through time, when what is considered is a process, an evolving state. In contrast, the commons metaphor from chapter 1 section 6 defines the bounds of the commons - within which each generation can operate and fairly share use - as what will allow it to continue to function healthily into the future.

Let me explain my concern with the justice metaphor by describing several analogies. Solow had referred to a theoretical "fair minded judge". But this is reminiscent of the biblical story (if I can be forgiven such an excursion) of the judgement of Solomon, which offers a useful metaphor. In the story, two women both claim to be the mother of a baby and ask King Solomon to adjudicate. Solomon then feigns a threatened 'fair' solution to determine the baby's true mother, ordering: "Cut the living child in two and give half to one and half to the other.". Whilst the false mother agrees with the ruling as a fair solution, the true mother "was deeply moved out of love for her son and said to the king, "Please, my lord, give her the living baby! Don't kill him!" But the other said, "Neither I nor you shall have him. Cut him in two!""[135] Thus the king recognises the true mother for her concern for the welfare of the baby – her recognition that its worth and value lies in its continued health, and that it is not the kind of thing that *can* be divided fairly.

[132] Rawls, 1972, p298.
[133] Apart from, possibly, the cumulative emissions budget, once set, over time, but see footnote 139.
[134] I expand on the idea of "well-being", which I understand as an objective concept, in chapter 3.
[135] 1, Kings 3:24-27, New International Version

Here is another, more direct analogy to the case of DACC. I plant a rosemary bush. There are a few small sprigs, say five, in the first year, and I know it will grow many more next year. How many should I take now? If I think in terms of an even distribution over time, I will encounter problems. Left as is, and tended to, the bush may have, say, 4 times as many sprigs next year and I will be able to harvest more. But if I try and act 'fairly' to myself in the future by taking five now, and five next year my plant will probably die. I could take three or four sprigs, and then try to take the same amount next year, but my plant probably will not be very healthy, may still die, and there are likely to be far less than twenty sprigs next year. What I need to do is take an amount that won't impede the growth and integrity of the plant – i.e. maybe one sprig. Then next year I can take at least five times the amount (i.e. five sprigs) without impeding its growth or health. Clearly, in this case it is I that benefit both now and in the future; one might object that I am simply acting in my longer-term self-interest, dis-analogously to the case of future generations. But the point of this particular analogy is not motivational; rather it is to highlight the limits in understanding the process of development over time distributionally[136].

As I outline in section 2.4, prevention of harms to future generations from DACC should instead be seen developmentally. That is, developing our society in a way that protects and enhances its ecological pre-conditions to enable its continued functioning and flourishing, and any current 'costs' considered in terms of *how* they alter its development, rather than straightforwardly as burdens that might be fairly or unfairly distributed intergenerationally[137]. For, if the concern of intergenerational equity or justice for future generations is to ensure equivalent burdens are placed on each generation, then the scenarios posed by DACC will create morally dubious outcomes, although this may not seem obvious initially. On the one hand, since burdens to future generations from DACC will be significantly heavier and more serious than those to current generations if we do not adequately mitigate emissions, an "intergenerational equity" approach might require reasonably radical mitigation targets so long as equivalent intergenerational burdens or levels of well-being were likely. However, on the other hand, the current and emerging

[136]All such analogies will be imperfect, because, as I suggested in 2.1, our relations to future generations are unique, and constitute a distinct ethical paradigm. But analogies can be used to draw out different aspects of the relationship. When the intergenerational justice metaphor is used, however, it is not sufficiently recognised *as* a metaphor, but rather as identifying future relations as the same kind of relations as between contemporaries.

[137] As I explain later, this does not justify just *any* costs; there must be a genuine transition, since we cannot immediately live within our means without fundamentally threatening the existence of society, and in this sense, the "costs" of mitigation are spread across e.g. a couple of generations.

generation, in committing to any such "burdens" or drop in standard of living could be arguably treated inequitably vis a vis the previous generation, which (at least in industrialised countries) benefited from high emitting development but which contributed to the burdens from DACC and the requirement for significant cuts if further GMT rises are to be avoided. To treat our generation "fairly" might then seem to imply less radical mitigation targets.

Furthermore, the prospect of radical mitigation targets might seem unfair if the current generation is considered in comparison to further future generations. For, if we were fortunate and extremely strong mitigation levels successful in averting a 1°C GMT rise, once infrastructure is in place adapted to low-emitting and a marginally altered climate, further future generations could conceivably end up substantially better off in many respects and facing fewer burdens than the current generation. This could be deemed unfair or unjust from the perspective of intergenerational justice but would surely be morally preferable to a more 'just' outcome, where the current generation only marginally diminishes its average[138] standard of living but future generations increasingly suffer the impacts of increased GMT rises.[139]

In general, then, use of the approach of intergenerational equity or justice to determine our obligations to future generations can be misleading in considering harm prevention from DACC in terms of fair harms, burdens, or costs in current and future generations[140]. I turn

[138] I use "average" standard of living because of intragenerational inequities, which may and should become more equitable (see chapter 3).

[139] NB it may be thought that a "sufficientarian" understanding of intergenerational equity might be able to deal with this better, i.e. interpreting the conclusions of section 1 as guaranteeing some minimum, "sufficient" conditions for well-being of future generations. E.g. Page, 2006, p70, considers an intergenerational application of Nussbaum's basic capabilities approach, such that "It will not be the aim of distributive justice to secure a resource base for future generations which is equal to that enjoyed by previous generations, or a non-diminishing social welfare function, but rather to preserve an environment that enables future persons to retain the same substantive freedoms to be healthy, well fed, and well clothed that their ancestors possessed". Whilst I think this captures some of the features I have been emphasising, for my view to be a version of sufficientarianism it would be radically different to other sufficientarian paradigms. Because Page, 2006, p91 has also highlighted how "the sufficientarian ceases to be concerned about the exact profile of benefits that pertains once everyone has enough", whereas I am suggesting that there are some respects in which sufficientarianism is not enough to meet our obligations to future generations. Whilst there are some things we do not need continually more of (e.g. material consumption), or which cannot continually improve (e.g. our ecological preconditions), there are other things which we surely want to see improved for future generations (if compatible with living within ecologically effective bounds), e.g. better healthcare. But the distributive justice metaphor deforms the way that we think about our descendants, since it stops us thinking about (genuinely) developing and improving our society; once we have "given" them what is "sufficient", we need not do more.

[140] It may be that the intergenerational equity approach is more applicable in guiding the rate of use of the cumulative emissions budget, *once* limits have been decided (emissions levels are increasingly understood in

now to outline the kind of approach which I believe should be taken, to recognise the asymmetry in our intergenerational moral relationships and our obligations to improve and develop ecological conditions for the well-being of future generations.

2.4. Becoming the future: Caring for the future as a development of the present

I now sketch the kind of alternative metaphor that I think also needs to be appealed to, to capture those features of intergenerational moral relationships ignored by the distributive justice metaphor[141]. What I have suggested is missing from, or mischaracterised by the former approaches in defining harms and obligations to future generations is, firstly, a conceptual recognition of the asymmetry and directionality of our relationship with the future. That is, an understanding of future generations not simply as another distinct group of peoples located elsewhere in time as opposed to space, but as dependent on us for the conditions and structures in which they live. This dependency should be understood not simply in terms of being recipients of capital, but in the sense that they emerge from us and our world; the form of their societies, the health of their ecosystems and their very identities, as was considered in 2.1. This is in contrast to the "saving" metaphor which implies a stockpile of goods, set aside and given to future generations. Rather, over time our generation *becomes* them[142].

This could be seen as enhancing the notion of strong sustainability which was introduced in chapter 1 (section 3.2). Strong sustainability, I emphasised, is generally contrasted to weak sustainability in considering that particular resources or functioning of processes should be sustained, rather than the aggregate of different goods and services. But I suggest this distinction should also involve recognising strong sustainability as a process of

terms of cumulative emissions between now and a set point in the future). Even this would not be straightforward, since making the reductions involve changing our systems and behaviours, weaning ourselves off emissions-based economies/societies, which means using *less* in the future. Perhaps aiming for equality of objective welfare (as considered in chapter 3, section 4) could be helpful, to avoid an emissions trajectory where most of the budget is used now, leaving an insufficient amount to meet needs from, say, 2025 onwards, whilst a zero-carbon transition is still being completed. We need the trajectory to allow, as far as possible, for such a transition. Even then, however, it is not necessarily a question of intergenerational *equity*, since standards of living could, in some respects improve over this transition (e.g. if people live more active lifestyles).

[141] This is predominantly an exploration, and I would like to develop this more in future work.

[142] In saying this I have some sympathy with De Shalit's notion of a transgenerational community, as "one that extends *into the future*" (De Shalit, 1995, p12). However, De Shalit oddly uses this to justify considering our obligations to near future generations in terms of intergenerational distributive justice (i.e. since they are a part of the transgenerational community, where conditions of justice apply), so it is therefore very different to my developmental approach.

protecting and developing functioning over time rather than "a matter of distributional equity"[143] of quantities of goods and services between generations. For in any case, the form of ecosystems and patterns of life shift, change and evolve over time, and are not static – this is, or should be, the distinction between mere preservation and sustainability.

This is secondly, then, relevant for our moral attitude to future generations. We need to consider our moral obligations to future generations and the prevention of harms in terms of investing in and shaping future conditions for flourishing – our responsibility for how our world will become - rather than considering future generations as competitors for intertemporal resources. Any gardener will be familiar with this way of thinking, exemplified through the rosemary bush analogy described above. For the land to support life in the future requires time and money to be spent working the soil, enriching it, planting seeds (which means, if they are from a previous crop, not consuming them) so that they can grow productively in subsequent years. More will be harvested in the future than now but this is a defining feature of the (directional) process. And this means holding back from some 'opportunities' now in use of particular resources and ecosystemic processes such as the GHG absorption capacity to ensure that future lives are liveable, even if quality of life ends up being better subsequently than ours is now.

For us to do this even when we ourselves will not directly benefit involves a bias towards the future; an attitude of love/care to future generations, as both Read and Jonas have suggested is analogous to our relationship with our children[144]. Future generations (including the wider ecological community) are not our competitors because they are our creations, our inheritors and, one might say, the development of our communities. This need not imply the kind of communitarian position advocated by De Shalit, which derives obligations to future generations from their membership of our *particular* "transgenerational" communities whose identity we want to prolong[145]. Such a position means we have fewer, weaker obligations to those outwith our community(i.e. to other transgenerational communities), which would risk, for DACC, collapsing back to a position of national self-interest. But for both Read and Jonas, our caring for future generations is not merely premised on our connection with our biological/community

[143] Anand and Sen, 2000, p2038
[144] Read, *Forthcoming(a)*, p4; Jonas, 1985, p39.
[145] De Shalit, 1995, p63

descendants; rather, in so far as we control both their existence and condition it functions as a metaphor on which we can model our responsibilities to future generations[146].

The costs or harms from DACC to future generations, therefore, should not be thought of in terms of an aggregate cost-minimising exercise or exclusively as an unfair intertemporal distribution of resources or well-being, but as a process that is diminishing/threatening the health or liveability of the earth's ecosystems in the future. It is in this sense that, as I suggested at the end of section 1, whilst a 1°C GMT rise seems clearly[147] to risk significant harm to our ecological preconditions, i.e. the impairing the stable functioning of many major ecosystems, in fact every increase in GMT over the past century has already begun to undermine their functioning, even if some areas may experience some temporary benefits.

This does not mean that possible current harms from mitigative action should not be taken into consideration. There is a sense in which we should balance these against harms it is intended to prevent. But this is not best understood as an attempt to equitably distribute the harms and benefits between generations, but about the society we want to be and to become. In fact, I suggest that so long as those threatened harms are not comparable – to the kind or degree of those we are trying to prevent from DACC, which damage the ecological preconditions of future generations[148] - they should not constitute justifiable reasons to rule out such a mitigation level. Mitigative action which fundamentally harmed current generations could be quite rightly objected to on the grounds that the lives of the current generation have value and no society which values human life could countenance causing significant suffering and live with itself. This can be taken quite literally if it is recalled that future generations originate from the current generation.

For it should be remembered that, as I have emphasised through section 2, future generations should not be thought of as a distinct society or group living at a different temporal location, but as what/who we will become, emerging from our generation, and the future identity of our society(ies). This means that whatever suffering we "impose" on

[146] Although Jonas considers the duties to existence to operate slightly differently in the case of future generations, 1985, p40-42
[147] As I have emphasised I deal in part B with the issue of likelihood and uncertainty separately.
[148] I.e. on the basis of the green economic picture in chapter 1 (part B, section 3.2), since the ecosystem is a precondition for economic functioning at all. See also chapter 2, part B section 3.4(iii), discussed in the context of the response justified by the precautionary principle.

current generations, will also be inherited by future generations. This is both in terms a psychological collective inheritance through their origins and history, but also affecting the conditions for social structures. If, therefore, solutions are pursued that result in total social disintegration, conflict, poverty, this will also threaten the social conditions for future generations – to an extent, it will be borne by them, as well as current generations. Indeed, it is a core concern for campaigners. For example, the TUC's report, *A Green and Fair Future*, which argues for a "just transition" to a lower carbon economy, highlights that past significant "economic restructuring" that was "chaotic" not only left "ordinary workers, their families and communities to bear the brunt of the transition" but "many individuals and communities in the UK are still paying the price from the rapid shift away from industrial production over the last 30 years"[149].

This means, therefore, that if achieving a particular mitigation level involved destroying the infrastructure of current societies overnight, the chaotic legacy left to future generations would not allow for stable or resilient future societies either. Although some revolutionaries might disagree (!), I mean here to imply the destruction of social, economic and industrial systems without effective replacement structures, in a way which would not allow effective transition to an alternative way of living or sustaining ourselves; i.e. they sever our (current) ability to make use of and survive in our ecological conditions. By contrast, it seems to me that the kinds of harms we can and should accept will include some limitations to what we can do – how far we travel and how frequently, the food we consume, other energy-intensive activities, and consequently some drop in standard of living, at least in industrialised countries[150]. These surely do not constitute harms of the same order as those we risk from DACC.

However, one concern may be that, even short of extremes such as immediate cessation of emissions, a deeper, rapid mitigation to achieve lower GMT targets risks exactly this kind of widescale economic collapse, because of the effects on economic growth, on prices and employment, resulting in disruption to food and energy access, and corresponding poverty and mass suffering. This might conceivably constitute comparable harm to that which we are aiming to prevent. And these sorts of harms might be seen to render deep mitigation

[149] TUC, 2008, p3
[150] Though see chapter 3 for a discussion of how the burdens of the mitigation target should be shared equitably between countries, since this would affect the kinds of costs imposed on each country.

targets not only as morally prohibitive but socially, economically, or politically impossible to implement.

But these questions – of moral appropriateness and of possibility - are deeply intertwined. Because whether or not such comparable harms would emerge from massive, rapid emissions cuts, depends largely on the possibilities created by our socio-economic system and the kind of measures governments (and communities) put in place. Of course, at one extreme, reducing the world's carbon budget to zero within days would clearly cause such immense chaos that almost no society would be able to function, let alone feed itself (i.e. because of the current dependence of socio-economic systems on high-emitting activities). However, excluding such extreme scenarios, the possibilities of making deep emissions cuts without significant harm depends on how people are (collectively) prepared to act, or change. And here it is a mistake to assume that attitudes, preferences and lifestyles are fixed or 'given', as I have argued in 1.2, and thereby treat the question of socio-economic possibility as a scientific one[151]. Attitudes, social and political modes of organisation and the way our economies work can alter and be altered such that some changes become possible (for example, because people are less driven by continuous economic consumption or because employment patterns are less reliant on long-distance travel), and will also, therefore, impose fewer harms from the same mitigation target under a different scenario.

This gives a deeper meaning to the concept of a transition to a zero-carbon society. What is increasingly argued by campaigners is that fairly radical mitigation targets could be achieved through a period of rapid planned transition – an "emergency climate stabilization program"[152] to reshape infrastructure to a zero carbon economy akin to the socio-economic shift in the second world war[153]. This need not involve significant 'harms' to the current generation if the transition adhered to the demands of intragenerational justice and was a "just transition"[154], involving for example, rationing of key goods and services within each society and between nations (see chapter three). Indeed as others have

[151] I develop this distinction between scientific uncertainty and social indeterminacy in appendix 2, section 1.
[152] Baer et al, 2009, p7
[153] Which would include massive investments in the energy sector – it could not occur based on the current investment levels. But this and other step-changes – to consumption, to waste reduction, to public transport - could occur, some, (eg Simms, 2011; Roodhouse, 2007) have argued, were Britain on "the equivalent of a war footing to tackle climate change" (Caroline Lucas MP, preface to Simms, 2011, p4).
[154] TUC, 2008.

pointed out, there could also be significant improvements – for example, to health through more reliance on physical skills and activities – walking, cycling, farming, and increased community cooperation as evident in the Transition Towns movement[155]. Low or zero carbon living need not be seen as a sacrifice[156], but as adapting ones aims and lifestyle to a new set of limitations and arrangements[157]. This therefore involves fundamental cultural, as well as socio-economic change[158]. It is in this sense that the questions of possibility of change and degree of harms to current generations are interrelated: in practice, some mitigation targets may seem socially, politically or economically 'impossible' largely because within current structures and change mechanisms the sorts of harm they impose on current generations would lead to social unrest, disintegration or economic collapse.

The aim, therefore, of policy, should be to ensure these changes *are* possible, to shift these parameters and transition towards socio-economic structures such that significant, comparable harms would not occur. This needs to be pursued at the same time, as part of, pursuing particular mitigation targets[159]. This might appear to side-step the issue. I do not mean to imply that it is possible to make such a transition or achieve this scale of mitigation without imposing *any* harms on current generations. As I have suggested, there are things people will be unable to do or have to do significantly less of (e.g. flying abroad regularly, high-energy consuming activities, meat consumption). But even these may not eventually appear as significant sacrifices if and as attitudes shift to recognise these activities as unnecessary and other benefits emerge (such as healthier, more active lifestyles). My point is that deep harms of a kind or degree approaching those we/future generations face from DACC need not arise for current generations, and the question of what is 'possible' or not to achieve is largely dependent on how we choose collectively to act[160].

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[155] See http://www.transitionnetwork.org/

[156] Although it would clearly still involve some sacrifices for some people adapted to high-emitting lifestyles, and used to e.g. frequently travelling long distances, car travel, high consumption.

[157] For this reason many Transition Town movements have a "heart and soul" group, a woolly sounding name, but which refers to a group focusing on psychological adaptation to a different way of living and the mental and spiritual challenges that accompany such changes.

[158] Ernsting & Rughani, 2008, p72 – 80 examine the kinds of changes that would need to occur.

[159] More work needs to be done on the viability of emissions reductions at this more (currently) radical end of the scale, and on how far (and with what kinds of policy mechanisms) a minimum sufficient but decent standard of living for all could be consistent with these kinds of reductions.

[160] I include here both political will and general social acceptance of the need for this kind of shift – these are clearly major barriers (!) in practice, but this is where the argument needs to be had.

This is not always fully recognised by those who consider the question of what degree of climate change is now inevitable, and what is/ is not possible to prevent[161]. There may be some DACC warming outcomes which may not be *geophysically* possible to achieve[162], because we are already committed to some additional warming resulting from the climate forcing of the existing atmospheric concentration (which takes time to emerge)[163] and the concentration will take considerable time to significantly reduce, even if all emissions immediately ceased[164]. Although there are still significant uncertainties surrounding warming already "in the pipeline"[165] and some of the assumptions in discussions around this also depend on some human choices, for example, over whether we can or should more immediately reduce current atmospheric concentrations of GHGs by removing carbon from the atmosphere.[166]

What, then, are the implications for specifying what constitutes a harmful GMT rise? Firstly, from what I have examined in section 1.3, any further temperature rise is harmful (given harms already occurring) and may risk more serious harms. This is important to recognise, since in this sense there is no 'safe' level of DACC (as I examine further in sections 3.2 and 4). However, it is still important for an international agreement to include particular limits which are plausibly achievable, which prevent even more serious harms, and around which common effort is rallied to keep within, at least on transition to more genuinely 'safe' limits in the future. That is, the 'ecological effectiveness' of an agreement can be understood in terms of short-term damage limitation, and an attempt to return us, globally, to a more resilient ecological set of conditions. This makes specifying GMT rise limits a difficult balance between being both plausibly achievable but not unnecessarily permissive/apologist for particularly severe and/or irreversible moral harms which might occur.

[161] See Hare and Meinshausen, 2006, for discussion of four interpretations of "warming we are committed to".
[162] Hare and Meinshausen, 2006, p115
[163] This is because of delays in feedbacks, for example, the slow response of the oceans. (see IPCC, 2007b, section 10.7.1)
[164] Matthews and Caldeira, 2008, p3; Hare and Meinshausen, 2006, p126
[165] Because equally, climate inertia means that the current atmospheric concentration may be lowered before all of the expected warming from current concentrations is realised, but it is unclear just how much. (Hansen et al, 2008, p225). See also Hare and Meinshausen, 2006, p117-121
[166] I.e. by using some form of geo-engineering in carbon capture or sequestration, much of which carries its own risks and is fairly controversial. See Ernsting & Rughani, 2008.

Given the discussion in 1.3 over recent understanding of the current impacts of climate change, those expected from a GMT rise of 1°C onwards, and the possibility of even more severe harms and crossing crucial tipping points as 2°C is approached, the widely-cited 2°C (above pre-industrial levels) GMT limit certainly now seems far too high. At the lower end, it is extremely difficult to determine what GMT rise we are likely to be already (physically) committed to. Of course, it may turn out that even 2°C is unachievable as a limit (see discussion in section 4), but this does not constitute a reason for keeping this as a mitigation target.[167] Given that it is likely that around a 0.8°C GMT rise has already occurred over the last century[168], it seems both plausible and morally incumbent on us to aim to create the possibilities to limit warming to between 1-1.5°C above pre-industrial levels, i.e. to attempt to stop any significant further warming. I discuss in section 4 how far this might be achievable, what it might correspond to in terms of emissions levels, and how far it might be compatible with a managed socio-economic transition that does not impose comparable harms to current or future generations.

Before I move on to consider the importance of uncertainty and likelihood, however, the question still seems to press: what if the socio-economic shifts required to achieve mitigation to prevent a 1-1.5°C GMT rise do not in fact occur, or cannot occur without comparable harm to current generations? Or, what if the situation turns out to be even more serious, or emissions reductions are further delayed, so that in several years time it emerges that even a just transition emergency pathway would not prevent GMT rises of 4°C or more, risking runaway DACC and maybe even a Planet Venus scenario[169]? Are the possible harms to current generations necessary sacrifices, which are trumped by the longer-term nature of harms from DACC? If so, does this imply a moral justification for their imposition through authoritarian rule? Here, I do not think there is any morally clear answer[170]. Were we truly to find ourselves in this position, we would be between a proverbial rock and a hard place. Perhaps in such a scenario one would need to revert to some form of utilitarian calculation in terms of numbers of people that would suffer, or the time for / ability of society to recover, particularly if we were speaking of very high GMT

[167] Because, even if it is ultimately missed, every effort will be needed to prevent even higher temperature rises. It may, of course, constitute a reason for adaptation preparations (as far as possible) to be made for this and higher temperature targets such as 4°C, as New et al (2011) have argued.
[168] IPCC, 2007b, *Summary for Policymakers*, p5
[169] Ernsting and Rughani, 2008, p72
[170] My application of the precautionary principle (see 3.4 (iii)) is to prevent the specified harms without causing comparable harms. However, I do not suggest that this rules out such action were such harms to occur; rather I think it is merely morally silent, in choosing between two pretty awful scenarios.

rises, where the permanent end to human civilisation, and much other life on earth could be a possibility. I will not attempt to provide an answer here. But what I have tried to show in this section is that the framing of such a scenario, in terms of a trade-off between harms to two different temporally located group is misleading; because the conditions from one emerge from the other, harms from one define the next, the choice faced in such a scenario is not the one that may initially appear.

Relatedly, the suggestion that such severe changes might need to be imposed through and justify authoritarian rule[171], seems likely to be another misleading choice. Briefly, I see no reason why ecologically-minded authoritarian governments who understood the need for urgent mitigation measures would be any more likely to emerge and take power, if a democratic system was unable to produce such rulers. But I also follow Achterberg[172] in believing that any changes that were so imposed could not be of the substantial and lasting kind necessary to achieve radical mitigation targets, and that it is a "necessary condition for a structural solution to the environmental crisis that it is permanently supported by as many people involved (citizens) as possible."[173]. For this, we need, at least in general, for society to be on board.

There does not seem to me to be any kind of moral principle that could guide us through such a scenario, in advance. Once we recall that future generations grow from and are formed by the structures and conditions of current generations, the dynamic is not simply a question of harms to 'them' versus harms to 'us'. Rather, the focus should be on how we can effect a transition to enable us to live within our ecological limits and boundaries of our global commons[174], and how we can achieve the transition without significant harms. But this is not merely a question of what we should give and take, but of the society and wider ecological community we want to create and to be. It is, therefore, also the question of how we can become the future.

[171] As Ophuls and Heilbroner had reluctantly argued in the 1970s, as being eventually necessary to limit economic growth and prevent conflict. See Ophuls, 1977, p145, and Heilbroner, 1975, especially p108-110.
[172] Who writes on participatory and liberal democracy. Although I depart from him in his faith in the suitability of Rawlsian Liberal Democracy.
[173] Achterberg, 1993, p82.
[174] Ernsting and Rughani, 2008, p72, consider similar questions.

Part B: Normative responses to Uncertainty in Climate Science

3. Uncertainty

The implications for mitigative efforts of the discussion above might seem to be complicated by uncertainties in climate science. This is the second component of 'danger' outlined in section 0 – how likely, or uncertain a harm is to occur. In particular, there are uncertainties in how far various potential climatic outcomes of rising GHG emissions – the harmful outcomes we are morally obliged to prevent – are likely to arise from any given level of emissions. As I suggested at the start of the chapter, this makes it unclear as to which mitigation target should be selected as corresponding to the GMT rise limit that should be prevented, which I have argued should be set at 1-1.5°C. The ultimate purpose of Part B of this chapter is to think through how this decision should be made, and define the mitigation target for the ecological effectiveness criterion. Uncertainties also clearly mediate the relationship between harmful effects of climatic change and the corresponding GMT rise that I considered in Part A. I do not (re)consider these uncertainties explicitly in part B, but the conclusions I reach about how we should respond to uncertainty can be equally applied to justify the approach I took in Part A[175].

I argue that the nature of the uncertainties present in climate science (considered in appendix 2) is such that they do not justify inaction, but neither should they imply responses which attempt to turn uncertainties into expected values which would allow a gamble on the outcome. Scientific uncertainty should be understood primarily in contrast to "risk" rather than to "certainty". This will form the basis in section 3.3 for understanding and defending an approach to the precautionary principle, and tackling some of the problems it has been argued to face. In sections 3.4 and 4 I am then able to consider the implications for selecting mitigation targets which should be pursued as morally sufficient and consistent with preventing the 1-1.5°C GMT rise limit that was advocated in Part A. I ultimately argue that the ecological effectiveness criterion would require moving towards atmospheric concentrations of 350ppm CO_2e, and a global transition to zero-carbon as soon as possible (without causing comparable harms) this century.

[175] I.e. broadly precautionary, but not significantly so; since we are already experiencing dangerous climate change, all that we can be precautionary about is preventing more severe/dangerous impacts.

In considering these responses, I allude to different ways of categorising uncertainty. Whilst the climate science literature on uncertainty has highlighted several major categories and kinds of uncertainty, there is nothing that systematically overviews the different ways of drawing distinctions and the levels at which they operate, in a conceptually sophisticated way. Therefore, I have attempted to delineate them in a technical appendix (appendix 2). There I describe four different levels relevant to climate policy, which I will outline briefly here for the purposes of the forthcoming discussion. Firstly I distinguish domains of knowledge: uncertainty *in* climate science is distinct from "theoretical uncertainty" over the truth of greenhouse gas theory and, further, from "uncertainty" over future human emitting actions, which I have termed "social indeterminacy"[176]. Secondly, I distinguish broad areas of climate scientific uncertainty, over: climate sensitivity, carbon sensitivity and the ecological impacts of global climatic change. Thirdly, I define the methodological sources of error and uncertainty that arise in these areas of climate science uncertainty. Lastly, I summarise the conceptual categories of scientific uncertainty which can be applied to these areas/sources of uncertainty offered by Stirling[177] and O'Riordan et al,[178] which are based on Knight's risk versus uncertainty distinction[179]: risk (probability known, outcome well-defined), uncertainty (probabilities unassignable, outcome well-defined), ambiguity (probabilities assignable but outcome poorly defined) and ignorance (neither probabilities or outcomes can be defined).

I now briefly consider the first possible response - that mitigative action requires certainty, or less uncertainty, before action is taken - which seems to misunderstand the nature of scientific uncertainty.

3. 1 Requiring Certainty

The presence of uncertainty is held by some[180] to undermine the need for strong mitigative action on DACC, not withstanding our obligations to protect the interests of future generations which would otherwise be triggered. The implication is that strong mitigative action requires near certainty, and that climate science currently rests on "unproven

[176] It should not count as genuine uncertainty, since human actions are dependent on decisions as yet unmade and can be altered, unlike scientific phenomena.
[177] Stirling, 2001, p79,
[178] O'Riordan et al, 2001, p24-25.
[179] Knight, 1921, p20
[180] E.g. fossil fuel producers, previous US administrations, discussed in Brown, 2002, p101-102

assumptions"[181]. The first general approach is therefore to postpone significant mitigative action to prevent possible harms from DACC until scientific understanding has further reduced or eliminated uncertainties in the areas described in section 2 of appendix 2.

Not all climate science uncertainties can even be quantified in terms of probability, and not all effects are wholly definable. Hence Stirling's distinction of "risk", not only from "uncertainty, but "ambiguity" and "ignorance"[182], as discussed in appendix 2. However, whilst the terminology might appear derisory, it should not be taken to imply inadequacy in the science. What these categories of uncertainty tell us is that it is not possible currently, whether in practice or in principle, to describe specific quantifiable relations from emissions level through to impacts. But, as Hulme has argued, to require certainty from science misunderstands how science works and our relationship to it. In particular, "scientific knowledge about climate change will always be incomplete and it will always be uncertain. Science always speaks with a conditional voice, or at least good science always does....Certainty is the anomalous condition for humanity, not uncertainty."[183] Uncertainty should not therefore indicate that science is insufficient to be action guiding[184].

One can have credible grounds for believing that harm will result from an action even if the relationship cannot be precisely quantified. By analogy, if I consume a high amount of salt, my uncertainty as to the exact level of salt that will cause me serious harm or heart failure does not justify my continuing to consume large quantities. As Claude Henry has argued, "If a decision-maker a priori rejects as 'scientifically unsound' any act which is not unambiguous… he neglects a large array of scientific information which, however uncertain, might be reliable and decisive". Henry reminds us of such an approach by British "public regulators" at the start of the twentieth century to the uncertain relationship between lung disease and asbestos exposure. UK authorities refused a ban until 1985[185], leading to severe "human and economic consequences"[186].

[181] Brown, 2002, p139.
[182] Stirling, 2001, p79,
[183] Hulme, 2009, p106
[184] Indeed, for Hulme, what counts as knowledge depends on social, public processes that require trust, and participation in the application of science (Hulme, 2009, p106-107), but I do not consider this procedural dimension here.
[185] Laverty, 2006
[186] Henry, 2006, p4

The "Uncertainty" of a future harm's occurrence can seem (psychologically) inadequate, or even reassuring in comparison to the gold standard of certainty. But one only needs to recall the corollary of the uncertainty of a given harm to revise this view; that the harm's non-occurrence / a benign outcome is also uncertain, and may be even less likely – it cannot be considered the default outcome. In the case of DACC, where, for example, harmful GMT rises of between 1.1 and 2.9°C above pre-industrial temperatures (i.e. which I have considered in part A as ranging from harmful to extremely harmful) are described by the IPCC[187] as "likely" to occur from emissions concentrations of 600ppm CO_2e, temperature rises below 1.1°C are, therefore, unlikely.

Whilst I will not consider here in any further depth such arguments against this approach, which has been adequately countered elsewhere, it is worth summarising two other main objections. The first, discussed by Donald Brown, concerns the time taken to resolve any (potentially resolvable) uncertainties. Brown argues that an ethical framing of the science and uncertainty of DACC would not ask "Is there enough scientific information?", since this does not account for the purposes of the information. Rather, the question should further add "…coupled with not enough time to resolve scientific uncertainties before harm occurs, to trigger an ethical responsibility to act now?"[188]. Even if scientific uncertainties might be potentially resolvable, therefore, this cannot be required if doing so at the expense of preventative action might allow possible harms to occur. Similarly, Yohe highlights how uncertainties of climate science, in particular, the range of the parameters in "climate sensitivity", are "so profound that they will never be resolved in a timely fashion", and that, therefore, proposals which seek "to delay immediate action in favor of waiting for the results of a "crash research program" to narrow their ranges is not viable"[189].

The second objection surrounds unresolvable uncertainties. These uncertainties are unresolvable either in theory, due to the source of error being "objective uncertainty"[190], or in practice, arising from complexity and deterministic chaos[191]. Requiring certainty in these cases would therefore require the impossible. Of course, the question still remains as to how much uncertainty is reasonable for action on possible threats to be taken, and whether

[187] IPCC, 2007a, *Summary for Policymakers*, section 3
[188] Brown, 2002, p6
[189] Yohe, 2009, p337.
[190] Dupuy and Grinbaum, 2005, p460-462. See appendix 2, section 3
[191] Dupuy and Grinbaum, 2005, p461. See appendix 2, section 3

mere possibility of harm is sufficient to trigger action. This will be considered in 3.3 and 3.4 when I consider the precautionary principle.

3.2 Accommodation of uncertainty in Cost-Benefit Analysis through "expected utility".

A second possible approach is the conventional economic treatment of uncertainties which attempts to accommodate them within the decision-making schema of CBA. This occurs either by ignoring uncertainties altogether and adopting "best guesses about likely outcomes"[192], or by basing calculations on the expected value or utility as a function of the scale and probability of a possible harm. The former is problematic in that it side steps questions about how far action should be taken in anticipation of other more or less costly outcomes. And where likelihoods cannot be determined at all or only for ranges of outcomes (as in estimates for climate sensitivity, see appendix 2, section 4), "best guesses" are not meaningful.

The latter approach based on expected utility is the approach taken by Stern. He explains:

> "Where we embody uncertainty formally in our models, we add utilities over possible states of the world that might result from climate change, weighting by the probability of those states. This yields what is known as 'expected' utility.
>
> This is essentially the extension of the social utility approach to an uncertain or 'stochastic' environment. As in a certain or 'deterministic' environment, it has its ethical difficulties, but it has the virtues of transparency, clarity, and consistency. Again, it is fairly standard in applied economics."[193]

This depends on formulating uncertainties as formal risks (in the sense of Knight and of Stirling considered in appendix 2), where the likelihood of a harm is assigned a probability, and the impact of the harm is described as a magnitude[194]. As such, as Stern acknowledges, it faces significant problems.

[192] Ackerman et al, 2009, p305.
[193] Stern 2006, p33
[194] Stirling, 2001, p68

Firstly, it has been increasingly criticised for its dependence on the ability to assign numerical probabilities. Stirling emphasises that what he terms the "narrow risk" approach (which with only one "yardstick of performance"[195], i.e. through CBA) is unable to cope with uncertainty or ignorance where there is "no basis for probabilities"[196]. And, this is often not possible because of the sources of uncertainty[197]. Even 'best guess' probabilities are subject to uncertainty and ignorance since they fail to reflect non-linearities or what have been termed "climate surprises"[198]. Schneider makes a similar point in acknowledging that "In reality... complete or perfect knowledge of complex systems, which would permit the credible calculation of objective or frequentist probabilities rarely exists. Likewise, the full range of potential outcomes is usually not known. Thus, risk almost always is accompanied by varying degrees of uncertainty"[199]

Larry Lohmann has likewise argued that climate surprises "render problematic reliance on probabilistic bell curves and conventional 'risk management' which assume that individual variation averages out and no single event is capable of changing overall trends"[200]. He argues that because of conventional economic dependence on CBA for decision-making there is pressure to "reduce these 'monsters' to (or frame them as) probabilities" and a "Weberian drive to use such numbers to tame chance"[201]. This tendency is clear in Schneider and Kuntz-Duriseti's approach, despite their concern for awareness of climate surprises[202]. Although they criticise most "integrated assessment methods" which "rarely consider low-probability, high consequence events", and instead "bracket the uncertainty"[203], they argue that the solution is to cast results "in probabilistic terms", i.e. ensuring the assessments include "as wide a range of eventualities (and their attendant possibilities) as possible"[204]. Whilst, as I suggest later, use of broad probabilities can be a

[195] Stirling, 2001, p69.
[196] Stirling, 2001, p78.
[197] See appendix 2, section 3.
[198] Although this should not be taken to imply, as has Henry, 2006, p6-7, that were the uncertainties of climate science fully quantifiable as risks, that decisions should be based wholly on expected CBA, for the reasons discussed in the preceding paragraphs.
[199] Schneider, 2001b, p4673.
[200] Lohmann, 2009, p514
[201] Lohmann, 2009, p514
[202] It should also be remembered that although termed "surprises", Schneider & Kunz-Duriseti remind us that they are better referred to as "imaginable surprises", since often conditions for the surprise to occur can be identified (Schneider and Kuntz-Duriseti, 2002, p58).
[203] Schneider and Kuntz-Duriseti, 2002, p58
[204] Schneider and Kuntz-Duriseti, 2002, p79

helpful guide in some circumstances[205], Lohmann is criticising the (in any case somewhat arbitrary) assignment of probability for CBA-based policy decisions, which will under-play worse-case scenarios, since their importance in such calculations is directly proportional to their likelihood, which might be outweighed by benefits of a higher likelihood.

Because, importantly, this approach suffers from the same kinds of reductivist problems as the use of ordinary CBA in decision-making (see chapter 1 section 3.2, and section 3.2 of this chapter). It attempts to by-pass value-judgements by trading-off and making commensurable combinations of different levels of danger and likelihoods[206]. This is inappropriate in part because, as Stirling argues, this "risk science" does not reflect how science works. He argues that a "scientific rationale" should fully recognise and represent "issues like multidimensionality, incommensurability and ignorance [which is, i.e. "an acknowledgement of the possibility of surprises"[207]]"[208].

But it is also problematic on an ethical level. For example, to decide between an action with a high likelihood of a low impact negative outcome and an action with a low likelihood of a high impact negative outcome, the product of the likelihood and the impact is factored in as an expected cost in each case. The action with the highest expected utility value would then be considered optimal. But whilst gambles of this kind might pay off for businesses in the long-term, in repeated runs of the process where the only relevant dimension is financial gain over time, when the potential costs are multi-dimensional, once-off and life-threatening as in DACC, the approach is morally misguided.

One aspect of this is how risk-aversion is treated. Stern argues that "The standard expected-utility framework involves aversion to risk and, in this narrow sense, a 'precautionary principle'"[209]. But this is only in the sense that more likely and more costly

[205] E.g. in sections 3.4(ii) and 4, where I use them to highlight the non-negligible likelihood of harms associated with raised emissions concentrations

[206] See also Stirling, 2001, p69, on the importance of multidimensionality and incommensurability. He points out that even where risks can be "adequately represented" through a "single metric", they will still be "inherently multidimensional in nature", e.g. considering severity, reversibility, geographical distribution of effects.

[207] Stirling, 2001, p78

[208] Stirling, 2001, p81-2

[209] Stern, 2006, p33. Stern is clear that this "narrow" approach to precaution is distinct from applying a precautionary principle; "The analytical approach incorporates aspects of insurance, caution and precaution directly, and does not therefore require a separate 'precautionary principle' to be imposed as an extra ethical criterion."

threats will be reflected as higher expected costs overall when expected utility is calculated. It fails to acknowledge the crucial ethical dimension of such judgements which might consider the prevention of some kinds of potential harms as non-compromisable. In such cases a more risk averse approach is appropriate, minimising the worst case negative impacts rather than maximising the most likely benefits. In other words, where lives and basic well-being are at risk, it is arguably preferable to settle for fairly likely moderate costs than less likely severe costs. This implies that for certain potential harms, as soon as the likelihood is non-negligible, risks should always be mitigated, irrespective of the likelihood of its occurrence. For example, a company considering an action carrying a low but non-negligible likelihood of causing human injuries or deaths would be judged irresponsible if it pursued this over an alternative action carrying a higher likelihood of less harmful impacts or with lower expected benefits, and judged therefore to have a higher expected cost.

It may be argued that what is contested in such scenarios is the weighting given to the impact of the possible negative outcome. This would then be resolvable by assigning very (perhaps infinitely) high values to morally reprehensible outcomes. But this masks the qualitative differences between different kinds of costs which require explicit ethical debate in forming judgements about them. Even if quantitative values were assigned to reflect their moral ranking, the expected utility calculation, as was argued to be the case for CBA across time in 3.2, would not then have any particular normative force above and beyond what had already been determined, and would at best be superfluous. Similarly, whilst some economic CBAs are more sophisticated and attempt to accommodate the decision maker's "aversion for uncertainty"[210] or degree of risk aversion[211], this only sidesteps the substantive normative issue.

Such tactics are also argued to problematically underlie the general drive to specify harmful (or safe) levels of DACC. Hence Lohmann argues:

> "immense effort has been expended in trying to determine a maximum 'safe' level of temperature rise (the by now famous 2C figure) as well as the probabilities that one or another course of action will keep temperatures below that level. This

[210] Henry, 2006, p8
[211] Ackerman et al, 2009 p302

framing arguably follows the strictures of rational choice theory more closely than those of atmospheric science. It attempts to integrate different types of value and uncertainty as a prelude to evaluating alternative outcomes based on probabilistic predictions about their consequences."[212]

Similarly, Foster has argued against over-reliance on quantification and predictive models to argue from policy drives to formulate specific long-term safe targets[213]. Because of the uncertainties inherent in the oversimplications[214] of "any predictive model of a real-world natural system"[215], he suggests that "we *create* uncertainty by trying to be precise"[216]. This is all too evident from the analogous financial crisis and the "market in complex new financial derivatives that lies at the root of the recent global economic crash", which Lohmann highlights. Here, use of "risk measurement models" to turn uncertainties into calculable risks "gave the illusion that everything was under control"[217]. We cannot afford this kind of catastrophe with the climate[218]. We should not, therefore, take an approach to policy setting that relies on such specificity: "identifying any target cut in CO_2 emissions... achieving which would enable us to avoid dangerous climate change is a kind of scientifically disguised whistling in the dark"[219]. For Foster, this does not mean such targets should be totally eradicated. He argues instead for "broad spectrum predictions" which are "quantitatively modest... seeking to predict in terms of directions, trends, broad magnitudes and possible scenarios, rather than anything more numerically specific"[220].

The implications go beyond a shift in the framing of scientific knowledge on climate change, to what we are aiming *for*. Although this is not explicitly articulated by Foster, it is suggested through his preferred approach to global carbon rationing as "*the least we can now do* to ensure that life goes on", rather than "*the most we can now have* while meeting our obligations to the future"[221]. This is taken further by Lohmann, and more tentatively,

[212] Lohmann, 2009, p514
[213] Foster sees this as a tendency in what he refers to as the "sustainable development framework", as opposed to a "deep sustainability" perspective. (Foster, 2008)
[214] I.e. of the kinds considered in appendix 2, section 3 in model parameters, reliance on representative data, non-linearities, etc. (Foster, 2008, p28)
[215] I.e. because of its complexity. Foster, 2008, p28
[216] Foster, 2008 p29
[217] Lohmann, 2009, p175
[218] Monbiot has made a similar argument in Monbiot, 2008.
[219] Foster, 2008, p30.
[220] Foster, 2008, p29.
[221] Foster, 2008, p129.

Schneider and Kuntz-Duriseti[222], who point towards use of the precautionary principle as part of a resilience-based approach. Lohmann argues that we should replicate the practice of "many small farms and indigenous peoples" in scenarios of environmental threat, who "tend… to value resilience and 'safety first' practices over probabilistic calculations of gain and loss or arbitrary, numerical 'safety margins'"[223]. This, he argues, is the contrast "between a resource or accumulation conception of livelihood and one oriented around commons regimes and community survival"[224]. If we really want to avoid the dangers of DACC, we should not seek the highest emissions level or temperature limit the world may get away with, but the levels least likely to risk damage to our ecological preconditions: a resilient climate system is the most precautionary[225].

3. 3 The Precautionary Principle

This brings me to the third approach to uncertainty on which I believe justification for mitigative action on DACC must rather depend; the precautionary principle (PP), which is gaining increasing support and recognition in international law[226]. Support has been drawn to its common-sense moral basis in the "everyday concept of precaution"[227]. Hence, in its most common form, it expresses "the intuitively simple idea that decision makers should act in advance of scientific certainty to protect the environment (and with it the well-being interests of future generations) from incurring harm"[228], although it has also been invoked for non-environmental harms, such threats to human health from BSE in cows[229]. Unlike the quantitative approach of expected utility, the PP does not, therefore, require assignment of probabilities to potential harms before they can be factored into decisions (although they may also guide the precautionary response to harm – see 3.4 (iii)). Rather, it requires only a reasonable, albeit uncertain, basis for assuming that harms may occur[230], for preventative action to be required. As such, it is able to accommodate Stirling's distinct kinds of uncertainty discussed in appendix 2, and allow for "breadth of framing, recognition of

[222] Schneider, 2001b, p4674. Schneider recommends "exploring the `resilience' paradigm (e.g., precautionary principle) alongside the `optimization' paradigm (e.g., aggregated cost-benefit analyses)"
[223] Lohmann, 2009, p515
[224] Ibid.
[225] This will become clear in section 4 when I examine current evidence of likelihoods and uncertainties associated with different post-industrial era concentration levels.
[226] O'Riordan et al, 2001, passim.
[227] Sandin, 2004, p462. Also see O'Riordan et al, 2001, p13
[228] O'Riordan & Jordan , 1995, p3
[229] Henry, 2006, p9.
[230] I return in 3.4(ii) to the idea of what constitutes a "reasonable basis".

incommensurability and acknowledgement of ignorance" which are, he argues, features of scientific knowledge and understanding. Thus, as Stirling argues, "a precautionary approach… might arguably be seen to be more scientific than the traditional 'narrow risk' approach"[231].

However, despite the appeal of its general moral approach, the PP can vary significantly in its form, interpretation and implications, a fact which has drawn criticism.[232] This vagueness could potentially undermine its normative application in policy decisions on DACC mitigation and justify both weak and strong mitigative action, a concern which O'Riordan and Jordan share:

> "precaution... may well run the risk of following the dangerously successful pathway pioneered by sustainability some time ago... To date, precaution provides few, if any operable guidelines for policy makers nor does it constitute a rigorous analytical schema"[233]

For example, Sandin distinguishes between "prescriptive versions" (such as the starting formulation) which state that action to prevent possible harms should be taken in advance of scientific certainty, and "argumentative" versions, which merely state that uncertainty may not be used as a justification for inaction to prevent harms, i.e. they define "a principle for what arguments are valid"[234]. The latter can be seen in, for example, the 1992 UN Framework Convention on Climate Change which asserts that "where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures"[235]. A more general distinction is described by O'Riordan and Jordan, between "weaker" versions that are "relatively protective of the status quo" and "stronger" versions "that predicate the need for much greater social and institutional change"[236]. These vary in emphasis on different aspects of the PP which O'Riordan and Jordan identify[237]. For example, "stronger" versions of the PP might require shifting the burden of proof for harm away from those calling for precautionary action and

[231] Stirling, 2001, p81-82
[232] Sandin 2004, p462 and Sandin et al, 2001, p288-9
[233] O'Riordan & Jordan, 1995, p2
[234] Sandin 2004, p470
[235] UNFCCC, 1994, article 3
[236] O'Riordan & Jordan, 1995, p7
[237] From O'Riordan & Jordan, 1995, p4-6

assume vulnerability of and therefore advocate minimal interference with ecological space, thereby allowing for a significant degree of scientific uncertainty[238]. "Weaker" versions, for O' Riordan & Jordan, will concern predominantly "life-threatening substances or activities", emphasise economic "cost-benefit analysis" in justifying action to avoid potential harms, and require a stronger knowledge-base of "sound science" of the harm and of the action required to prevent it[239].

One immediate concern, therefore, given the argument of 2.2, is that it seems perfectly possible for versions of the PP to embrace CBA in the same way as the "narrow risk" approach, and therefore to suffer the same limitations[240]. Indeed, Dupuy and Grimbaum read the PP as embracing this same conventional economic ideology by relying on CBA; that it ignores objective uncertainty[241] and cannot deal with human choices appropriately, treatin them as additional parameters of future scenarios[242]. However, although it is sometimes framed in these ways, this is not normally the case[243].

These concerns underline the need for those applying the PP in any particular case to be explicit about and justify their interpretation of the varying elements of the PP. To do this, it is helpful to have a clearer general formulation of the PP which frames its contentious dimensions. In the subsequent section I draw from two similar attempts at a common formulation to show how I believe it should be applied to the case of DACC such that it does not rely on CBA or a misrepresentation of uncertainty[244].

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[238] O'Riordan & Jordan, 1995, p7

[239] Ibid.

[240] This is how Henry understands it, (Henry, 2006, p9), arguing that "precaution requires that the decision maker optimizes on a set larger than the set of scientifically unambiguous acts", i.e. that CBA calculations should include uncertain outcomes.

[241] Dupuy & Grinbaum, 2005, p462.

[242] Dupuy & Grinbaum, 2005, p464

[243] Sandin, 1999, p894 emphasises that CBA is unnecessary. Sandin does seem to frame uncertainty epistemically (p894) rather than regarding objectively unknowable phenomena, in the way that Dupuy & Grinbaum criticise. However, Sandin does also criticise formulations of the PP which require precautionary action "*before* full scientific proof is established" as though "'full scientific proof' is something that is to expected" because some issues are "trans-scientific" (p893). The PP *need* not, then, refer to epistemic uncertainty alone. Additionally, the use of scenarios by the IPCC include human choices as uncertain parameters as Dupuy and Grinbaum criticise (see appendix 2, section 1), this is not true of the PP per se. It should instead be understood as a principle intended to *guide* human decisions. Indeed, Stirling, treats it in this way, emphasising that it should "Allow iteration, reflexivity, and open-endedness in the interaction between sustained scientific monitoring, continued analysis and inclusive deliberation in appraisal. The process is never definitively complete" (Stirling, 2001, p 90). This largely encompasses the ideas behind Dupuy and Grinbaum's proposed "ongoing normative assessment" (Dupuy and Grinbaum, 2005)

[244] However; as I explain shortly I do not consider this general formulation to be the basis for one universal "rigorous analytical schema" (as O'Riordan and Jordan imply) that could / should be applicable in all cases.

3.4 Refining the Precautionary Principle

As has been highlighted, versions of the PP can significantly vary – so much so that it might be better considered as a group of principles[245]. Both Sandin and Manson have offered alternative logical formulations of the PP which attempt to capture its "generic elements"[246]; a "core structure" common to all formulations which differ in how these elements are interpreted.

Manson describes three main elements: "e-activities", "e-effects" and "e-remedies", such that "for a given *activity* that may have a given *effect* on the environment [the prefix "e-"], the PP is supposed to indicate a *remedy*"[247]. "E-effects" therefore include potentially harmful outcomes and "E-remedies" are interpreted broadly, to include an "outright ban on the e-activity… strict regulation of it, and further research into it". Manson suggests that these can be seen as related by a "three-part structure" composed of three conditions. The "damage condition" "specifies the characteristics of an e-effect in virtue of which precautionary measures should be considered". The "knowledge condition "specifies the status of knowledge regarding the causal connections between the e-activity and the e-effect". Lastly, the third (nameless) condition "specifies the e-remedy that decisions makers should take in response to the e-activity".

Sandin similarly highlights four "dimensions" to the PP. First, the "threat dimension" which "concerns the possible threat", the "uncertainty dimension" which "concerns the limits of knowledge", the "action dimension" concerning the "response to the threat", and the "command dimension" which concerns how strongly action is prescribed[248]. The common structure relating these dimensions is then cast as follows:

> "*If* there is (1) a threat, which is (2) uncertain, *then* (3) some kind of action is (4) mandatory."[249]

[245] Sandin, 2004, p468
[246] Manson, 2002, p264
[247] Manson, 2002, p265
[248] Sandin, 1999, p891.
[249] Ibid.

These therefore broadly correspond to Manson's three conditions (with 3 and 4 jointly approximating Manson's "e-remedy"). Both remarkably similar structures could allow for the "weaker" and "stronger" forms of the PP distinguished by O'Riordan and Jordan. For example, as Sandin highlights, "the smaller the threat that triggers precaution, the stronger (i.e. more cautious) is the principle". The formulation is therefore "very general indeed, allowing considerable room for variation"[250]. Any appeal to the PP must make clear how each of the "dimensions" or "conditions" is being applied. I now sketch this for the case of the threats posed by DACC. I shall predominantly use Manson's language of "conditions" rather than Sandin's "dimensions", since the former more explicitly express their function as part of the principle.

It should be emphasised that my aim is to clarify how I apply these conditions of the PP in the case of DACC. Here I treat the PP as a framework for reflection, not a theory, where the conditions guide considerations in each case. This is in contrast to the tempting, but ultimately unhelpful, approach of specifying a universally applicable formulation of each condition of the principle, a particular weaker or stronger version, such that it can be used to wholly determine in advance all possible cases, including DACC. This is to treat the formulation as a calculating mechanism for determining decisions in advance of each particular case, where values can simply be in-putted to produce appropriate e-remedies or determine whether precaution should be applied. This is tempting because, for supporters of either weaker or stronger applications of the PP, there will be a concern to make it applicable to cases which most clearly merit precaution, and to exclude those which seem clearly ridiculous (in that they would prevent any action being taken at all for fear of harmful impacts). However, I think it unhelpful, in that moral 'grey areas' (across which stronger and weaker formulations attempt to delineate the principle so as to allow or exclude them) will still exist and require debate, and no degree of specification in advance can remove the need for such moral argument as new cases emerge.

I elucidate further on this in considering each condition. But additionally, seeking such a specific formulation would also be unhelpful because the conditions are inter-related and different combinations of damage, knowledge or e-remedy conditions might be advocated concurrently. This makes it possible and entirely consistent to advocate different versions of the PP at the same time. For example, one might support both A) "If there is (i) a

[250] Manson, 2002, p265, of his own formulation.

catastrophic, irreversible threat to human health (e.g. a risk of widespread infertility) for which there is (ii) not conclusive scientific proof but significant evidence, then (iii) all necessary steps to prevent the threat should be taken" and B) "If there is (i) a minor threat to human well-being (e.g. headaches from a food additive) which (ii) cannot be ruled out from scientific study, then (iii) further research should be undertaken and alternatives used where possible.".

i) The Damage Condition.

Regarding the damage condition, then: I do not think this is best understood as a condition which must be met or specified to trigger use of the PP per se[251]. Rather, because of the range of possible precautionary actions - 'e-remedies'- it should be considered jointly with/ in relation to the other conditions. That is, in a particular kind of case, given the nature of the harms under the damage condition (i.e. for any given values of the damage condition), combined with the knowledge condition, it should be argued why this merits a particular precautionary response[252]. We need not, therefore, as Sandin, suggests, specify 'criteria' for the damage condition, although it is still helpful to consider such features of the possible harms, in conjunction with the knowledge condition, to argue for the appropriate e-remedy. Thus, the features which Sandin cites from Fleming, of "severity… reversability… and preventability"[253] might be mapped to the e-remedy in warranting strong regulatory action to limit or eradicate the activity in question, even if they are not criteria for use of the PP per se[254].

In the case of DACC, I have, in Part A, argued that the kinds of harms we are concerned with are to the ecological preconditions for functioning and flourishing of future generations, (which, as argued in section 1.3, includes harms to humans and non-humans). They are therefore harms of the most severe and fundamental kind, and, whilst in other cases of less severe harms it might be justified to argue for application of the PP and

[251] Other than in very general terms understanding it as relating to harms to well-being of humans or certain non-human entities.
[252] This might seem to unfairly move the burden of proof away from potential perpetrators of environmental harms. However, it could equally be considered as applying to potential perpetrators: as a requirement that, for all actions where harms are possible, they must consider whether the combination of damage and knowledge conditions merit stopping their activity, and, if not, they must demonstrate why they do not.
[253] Sandin, 1999, p892,
[254] Even "preventability", which might appear to be a necessary requirement for *any* use of the PP, on reflection may not be necessary for some possible 'e-remedies', which, in some cases, might involve other forms of preparation or adaptation.

corresponding e-remedies of particular kinds, it is unnecessary in the case of DACC. I take here as defining harms in the damage condition the 1-1.5°C and above GMT rise that I discussed in Part A (in so far as it may also be preventable).

How far are these harms also irreversible[255]? On the one hand there is contention over how far the process as a whole of DACC – i.e. of rising atmospheric emissions concentrations and GMT – is ultimately irreversible, or, rather, at what point "runaway climate change" might kick in[256]. Such an outcome might imply, in the e-remedy condition, an even stronger preventative action for these higher GMT rises. However, in any case, Solomon et al point out that GMT rises from DACC are still "essentially irreversible" from the point of view of humanity[257]. Because, excluding the possibility of geo-engineering removing existing atmospheric CO_2, "atmospheric temperature increases...are not expected to decrease significantly even if carbon emissions were to completely cease"[258], over a timescale "exceeding the end of the millennium in year 3000".

We might also consider how far damages to local ecosystems and global ecological processes that result from GMT rise are also reversible in the long run. However, when we consider the harms in terms of the effects of GMT rises on ecosystem functioning, the idea of reversibility is problematic. Ecosystem damage cannot be reversed in a straightforward sense since ecosystems constantly alter and develop in structure over time and should not be thought of as static entities which could be preserved, even if GMT rises were to be reversed. Rather, it seems preferable to consider how far and how quickly any such damage to ecosystems would be *remediable*, such that they can continue to function in a relatively stable and rich way once again. The same would be applicable for human communities functioning as part of that ecosystem. How far this is the case is also

[255] Manson expresses concerns about the conceptual clarity of including "irreversibility" as a damage condition because of the potential for including insignificant irreversible processes. Sandin's approach to this seems self-evident, in suggesting that "irreversibility in itself does not make a threat severe", but rather that "a threat is rendered more severe by irreversibility" (Sandin 1999, p892, my emphasis). This is certainly how irreversibility is understood in the DACC literature, see e.g. Solomon et al, 2008, abstract, first line, "The severity of damaging human-induced climate change depends not only on the magnitude of the change but *also* on the potential for irreversibility" (my emphasis).

[256] Even, ultimately, a "planet venus" scenario, Ernsting & Rughani, 2008, p72

[257] Solomon et al, 2009, p1704

[258] Solomon et al, 2009, p1704. This in part because of the atmospheric lifetime of CO_2, which, after a millennium, is still estimated to be about 40% of the highest atmospheric concentration reached that is additional to pre-industrial levels (p1705). But also because of the earth's climate inertia in warming according to the level of radiative forcing (p1706). And if concentrations decline, warming can still continue to increase "and remain elavated for at least several centuries", meaning these are changes that are "effectively irreversible on human timescales" (Matthews & Caldeira, 2008, p1).

uncertain (and, in the latter case, partly indeterminable – see appendix 2, section 1). However, even if some are ultimately remediable in the longer term, the intermediate effects on near-future generations are arguably irreversible from a near-future perspective, in that they may still affect and undermine the preconditions for well-being through several generations.

These features will need to be recalled when I return to the e-remedy condition. But the e-remedy condition will also need to be considered in light of the knowledge condition, which concerns the status of uncertainty, and which I turn to now.

ii) The Knowledge Condition

This condition might seem to require some degree of specification in advance, unlike the damage condition. It does not seem sufficient for the PP simply to state that a threat be "uncertain" to trigger an e-remedy of any kind, because of what Sandin refers to as the "argument from absolutism". This is the concern "that the PP will prohibit *every* action, and thus offer no action guidance whatsoever". This argument assumes that the PP prohibits any action that "might lead to damage", and, as Sandin suggests, "every activity is associated with some risk of damage":

> "My wearing of a bow tie at a party *might*, for instance, through a highly complex causal chain, result in the end of the World. Far-fetched, but not impossible".[259]

This might appear to require delineation of the knowledge condition to rule out, as I suggested earlier, clearly ridiculous claims. For they can be countered if one contends, with Sandin et al, that although the PP "requires that actions be taken when there is lack of full

[259] Sandin, 2004, p470. A similar concern is also described in Manson's depiction of the "Catastrophe Principle" where "the mere possibility of catastrophe" (Manson, 2002, p273) forms the knowledge condition and allows for e.g. arguments undermining an international treaty on emissions reductions based on the possibility that it sparks a "global economic depression… Massive social unrest…Totalitarian dictatorships…" which instigate a nuclear war. This is also, as Manson highlights, a (negative) variation on the problems facing Pascal's Wager. Pascal "contends that one is compelled by rational self interest to believe in God. So long as the probability that God exists is nonzero, the infinite nature of the reward if one correctly believes that and acts as if God exists makes belief in God rational—no matter how low that probability is.", but this can "lead to contradictory practical demands" when other "possible deities" are introduced (Manson, 2002, p272).

scientific certainty"[260] this "does not mean that precautionary measures are required when there is no particular evidence, scientific or other, of the presence of a possible hazard" [261]. One could, therefore, specify the circumstances under which a possible threat is held to be reasonable. I.e. the knowledge condition could "state a degree of evidence"[262] required. Alternatively they suggest a "de minimis principle"; identifying a "threshold"[263] below which threats are ignored. However, as they acknowledge, this seems to move "towards a risk-based approach"[264]. Whilst Sandin et al consider this merely as a "rhetorical" concern, and less important than that the PP is "applicable as a decision rule"[265], it should be recalled that it must be able to accommodate the conceptual categories of scientific uncertainty (see section 4 of appendix 2), and different kinds of threshold may be appropriate in different kinds of case.

My suggestion would be simply to supplement the notion of uncertainty with a general requirement (in my view, already implicit) that the threat must be more than merely conceivable or logically possible. Such a requirement might run as follows:

> *An action can only be considered to pose a threat under the precautionary principle if there are particular and reasonable grounds to believe that the threat might be caused by actions of this particular kind, rather than from any action generally.*[266]

It may be then tempting to seek further refinement to rule out unreasonable grounds, such as the claims by an Iranian cleric reported in 2010, that "women who do not dress modestly… spread adultery in society which increases earthquakes"[267]. But I think this is

[260] Although, as Sandin emphasises elsewhere, full scientific certainty is "a rare or non-existent commodity" (p893). See my comments in section 3.1 on the problems in comparing uncertainty to certainty.
[261] Sandin et al, 2002, p291. Sandin also initially suggests another approach. This is to imply that the argument/criticism is only valid against "any principle that prescribes globally precautionary acts", but that by specifying a particular "outcome x with respect to which a course of action is meant to be precautionary… the argument from absolutism does not necessarily apply". However, this is somewhat unsatisfactory, it must still be explained why precautionary action with regards to this particular outcome is justified. Counter-examples might be provided of where outcomes similar to x would not warrant precautionary action, e.g. when such outcomes might plausibly result from *any* action.
[262] Ibid.
[263] Ibid.
[264] Sandin et al, 2002, p292
[265] Ibid.
[266] This is similar to Sandin's preferable "reasonableness criterion" elsewhere (Sandin, 2004, p467); however, I have emphasised the role of causality in reasonable beliefs to rule out the kind of far-fetched interpretations suggested earlier.
[267] BBC Online, 20th April 2010, http://news.bbc.co.uk/1/hi/8631775.stm

unnecessary, since different kinds of cases will call for different grounds. For example, one counter to the earthquakes case might be to require "scientific" grounds. However, there might be non-scientific grounds for judging a threat to exist, for example, social grounds for the particular detrimental social effects of an activity. And even the idea of what constitutes 'scientific' grounds would require further specification, if one is considering ideas outwith or at the edge of the current scientific paradigm[268]. Ultimately, I suggest, the thinking needs to be carried out in each case, and my treatment of the Sandin-Manson PP is to apply it as a framework, not a theory. We should trust that we already know, roughly speaking what kinds of examples do or do not clearly constitute reasonable grounds or credible beliefs in the possibility of a harm's occurrence[269], and to fulfil the knowledge criterion we need to argue why ambiguous cases are more like Henry's asbestos example from 3.1 than the case of the Iranian cleric.

And we can do this in the case of DACC, where it is clearly of the nature of the former, rather than the latter. There are widely accepted and evidenced[270] grounds for believing that GMT rises within a certain range will occur from particular levels of GHG emissions. Aspects of this evidence and understanding of the mechanisms display risk, uncertainty, ambiguity and ignorance (see appendix 2, section 4), but the grounds are nonetheless credible for believing that the harms considered in Part A will occur at some level of increased GHG emissions. The uncertainty therefore constitutes a reason for implementing an e-remedy. In this way the PP framework also allows for these different categories of uncertainty, without requiring likelihood to be expressed formally in terms of probability or a detailed understanding of harmful effects.

It might be asked whether it matters for the knowledge condition *how* uncertain or likely a harmful effect is to occur. Again, I suggest this is better considered on a case-by-case basis than delineated in advance, since one should consider the interplay between the kind of harm being considered, the e-remedy, and the nature of the uncertainty (i.e. in so far as it falls into the categories and sources of uncertainty considered in sections 3 and 4 of

[268] Sandin attempts to encompass both by suggesting that "good reasons" just constitutes reasons that are "somehow externally good, external to the agent" (Sandin, 2004, p467)
[269] I am making a roughly Wittgensteinian point in suggesting that the "reasonableness" of grounds or beliefs cannot be straightforwardly defined as having a particular empirical scope, but is a judgement we must know how to apply if we understand the meaning of the word. Unless we disregard some odder possibilities we can never move forward. See Wittgenstein, 1974 (passim).
[270] I.e. through the four IPCC reports published since 1990.

appendix 2). Generally, there might seem an increased imperative for stronger action the more likely and less uncertain the harm; however, as I argued with regard to "expected utility" approaches to uncertainty, when we are considering one-off 'games', with such severe harmful outcomes, it should not be treated so straightforwardly. I briefly consider this in the case of DACC when I examine the e-remedy condition shortly, and suggest how the different uncertainties and likelihoods of GMT rises of over 1-1.5°C occurring from different emission levels might lead via the PP to particular mitigation imperatives.

Lastly, there may be concerns that the requirement of reasonable grounds for concern places the burden of proof on those seeking to prevent harm, rather than the perpetrators, as the PP is normally envisaged as doing. However, there is no reason this should be the case. The existence of reasonable grounds is not a requirement that the concern be underpinned by years of expensive research and demonstration of a connection. Rather, that there are grounds for believing harm could result from an activity; an argument that shows why it might be thought to arise. Those wanting to undertake the possibly harmful activity would still have to demonstrate why these grounds do not bear out. In this sense, I am countering Manson, who argues that the PP can either place a high burden of proof on perpetrators or, (which he points out could be equivalently strong) place a low burden of proof on advocates of the principle, i.e. establish very weak standards to trigger it[271]. I do not think that one has to choose. In fact, I suggest that the defining feature of the PP as an approach to uncertainty is what I suggested in 3.1: that it asks us to frame uncertainty about harm not in the context of certainty (i.e. and require proof that a harm *will* occur from an activity) but in the context of uncertainty about harm-avoidance (i.e. considering our confidence that harm will *not* occur from an activity). The latter still requires some reason for believing that harm could arise (for doubting harm-avoidance in the first place) so there is inevitably also some justificatory burden on those wanting to apply the PP.

iii) The E-remedy Condition.

The third condition, highlighted earlier, might vary significantly in what precautionary actions it advocates, from complete prohibition of an activity to further research. Whilst particular policy tools are best decided elsewhere (e.g. particular tax or regulatory mechanisms), I consider here the appropriate level of response to the threat, given features

[271] Manson, 2002, p268-9.

of DACC from the damage and knowledge conditions. Donald Brown has stated that the precautionary response should be "proportional to the magnitude of the harm"[272]. But it needs to be made clear how "proportionality" could be understood non-quantitatively, and without resorting to CBA.

A similar concern arises in what Sandin calls the "argument from risk trade-off". This argument criticises the PP for creating further risks from strong precautionary actions. For example, "substitution of hazardous chemicals" poses risks that "we are driven to use substitute chemicals that might be less neurotoxic, but may instead be carcinogenic"[273]. However, as Sandin et al have responded, "this problem does not depend on the PP itself but on the limited framing of the decision problem to which it is applied"[274], and rather, "the PP should be applied also to the precautionary measures prescribed by the PP itself"[275]. This might sound suspiciously like the start of an infinite regress. But in fact, what it reminds us is that we must consider harmful effects of both the initial activity and the mitigating actions, and decide whether it is more precautionary to pursue one or the other. This should be a common-sense notion, and is what, I suggest, is implied by 'proportionality': that in pursuing precautionary measures, one clearly should not create worse[276] threats than were initially faced. What seems less clear is *how* such a comparison should be made, and using which standards.

At this point, CBA might seem to provide the most obvious mechanism for judging proportionality[277] which takes it very far from the resilient-based notion of precaution considered at the end of 3.2. The appropriateness of the e-remedy could be judged by a comparison of costs from the e-effect and from the e-remedy. However, this is then subject to the same problems as the "narrow risk" approach, reliant on "expected utility" and the formal combination of likelihood and impact, so cannot constitute part of a genuinely precautionary approach. But judging the proportionality of response and comparing potential threats need not involve such a narrow quantitative analysis. Rather, as I have suggested in Part A, section 3.3, they can be considered on the basis of qualitative (and

[272] Brown, 2002, p143.
[273] Sandin et al, 2002, p293.
[274] Ibid.
[275] Sandin et al, 2002, p294.
[276] In terms of severity or likelihood
[277] Indeed, US legislation weighs the costs and benefits of precautionary action, and "prevention or anticipation is framed in choices of possible options, and payoff" O'Riordan et al, 2001, p27

broader quantitative) aspects – the kind and degree of threat that is posed to human and non-human well-being. Whilst disagreement will exist about the moral criteria for such a ranking, the basis available here is precisely that outlined in chapter 1, following a picture of the human economic and social spheres as part of and dependent on the ecosystemic one. That is, the seriousness of the threat can be judged on how fundamental to human and eco-systemic well-being the harm would be, making use of Daly's notion of an "inverted pyramid" (see Chapter 1, section 3.2) of dependency.

This would counter arguments from risk trade-off used in the case of DACC which contend that the risks posed to the economy from strong emissions reductions undermine the use of the PP to prevent the harms from DACC. For the risks to human and ecological well-being, as discussed in Part A of this chapter, are far more fundamental to survival and flourishing than the economic costs posed by mitigative action, and of course, they are also therefore risks to our economic system in threatening its ecological preconditions[278].

Accordingly, the application of the "e-remedy" condition which I am advocating runs as follows:

> *Given the severity of harms from DACC, the action taken to prevent them should be proportional to the potential harm, in that it is the strongest action available which does not pose threats of a comparable or more serious kind to human and ecological well being.*

What about different categories or degree of uncertainty? Or, where known, the likelihood of a harm's occurrence? I suggest that in the case of DACC, this should hold largely irrespective of the kind or degree of uncertainty (so long as they have fulfilled the knowledge condition of having reasonable grounds). Even if likelihoods are assigned, because we are considering such severe and fundamental harms, unless the likelihood is extremely negligible we should not divert from the idea of proportionality to the potential harm.

[278] Although some economic harms might be comparable in threatening our well-being, as discussed in part A, section 2.4, (e.g. if society was left literally at the point of collapse), in that they would remove the basic organisational structures which currently enable us to make use of and survive in our ecological conditions at all, e.g. to enable us to feed ourselves, to live in communities, etc, and which provide us with the basis to shift our society towards a zero carbon alternative. We have to be able to actually make a transition, and for this reason cannot be required simply to stop emitting activities tomorrow.

Again, it should be emphasised that this is not to propose a universal specification of the "e-remedy" condition, since it may not be morally appropriate for other cases to which the PP is applied. The harms may be of a different kind or severity, and the uncertainties may be different. Rather, this is a clarification of how I believe the e-remedy condition should be applied in the case of DACC. Another concern may be what counts as an "extremely negligible" likelihood. This is not clear, but again, it is unnecessary to delineate in advance. As with the issue of "reasonable grounds" in the knowledge condition, some cases of negligibility are clear, and others need to be taken on a case by case basis. For example, even a 5% likelihood of GMT rises of 1-1.5°C or more still seems non-negligible when the severity of accompanying harms to our ecological pre-conditions is recalled. Whether or not a 0.5% likelihood or less of the same harms counts still counts as non-negligible might be more doubtful, but either will in any case depend on whether they are higher than the probability of such a rise at pre-industrial atmospheric concentration levels, i.e. prior to marked anthropogenic interference[279]. However, in any case, these are not the kinds of likelihood that we are faced with here. Sadly[280], in the case of DACC, since our mitigative responses have to be in theory and in practice achievable (in the senses of "possible" that I outlined at the end of Part A), all plausible atmospheric concentrations which we could globally keep within this century have a clearly non-negligible likelihood of exceeding 1-1.5°C. I examine this in the last section.

4. Implications.

I now draw out the policy implications of applying the PP as elucidated in 3.4, to the harms I described in Part A, by referring to research on uncertainties of the temperature that is likely to result from particular levels of GHG emissions[281]. I look first at what the

[279] I.e. since there will always be uncertainties surrounding the global climate system and fluctuation of GMT.

[280] Or, rather: frighteningly, miserably and soberingly. Whilst neutral, non-emotive language is customary in philosophical writing, when applied to an issue such as DACC that threatens the very future conditions of our (and other species') survival, some degree of rhetoric seems warranted, indeed appropriate.

[281] Although I focus on aggregated GHG concentrations and GMT, as I suggested in section 1.1, this is largely for simplicity; measures of harm other than GMT are needed to reflect other ways in which emissions cause climatic harms (Lenton 2011a & 2011b), as well as implementing separate caps/ reduction levels for different GHGs. The latter is also implied by Solomon et al, 2009 (p1709), who argue that because of the "unique long-term effects" of CO_2, it should not be seen as interchangeable with other GHGs on the basis of its similar radiative forcing effects in the scale of a century, as it is currently. We need a separate cap at least for CO_2.

precautionary atmospheric concentration of emissions might be given current scientific understanding, before considering the implications for levels of emissions reductions. As is discussed in appendix 2, any probabilities describing the relationship between emissions level and GMT rise are themselves subject to uncertainty because of uncertainties about climate sensitivity, carbon cycle feedbacks and climate inertia. The aim is not, therefore, as criticised in 2.3 and 3.2., to determine a maximum 'safe' level from formal quantified risks[282], but, following Foster, to identify a "*broad-brush* prediction"[283] of the emissions levels that are most likely to allow liveable ecological conditions to pertain, and to indicate those where non-negligible probabilities of DACC still exist.

Most research examining the relationship between emissions levels, atmospheric concentrations and likely GMT rise focus on probabilities of exceeding or staying below 2°C, since this has been the most widely proposed target in policy circles. I therefore examine some of this as well as those considering lower targets in order to give an indication of the rough emission reduction levels at a precautionary e-remedy would imply to prevent GMT rise of over 1-1.5°C (Current atmospheric concentrations[284] are roughly 390ppm CO_2[285] and around 375 ppm net CO_2e or around 460ppm CO_2e for Kyoto GHGs[286]).

[282] I.e. because it is not clear that this notion makes sense with regard to ecosystemic functioning.
[283] Foster, 2008, p127
[284] NB some authors consider CO_2e, which attempts to aggregate different GHGs in terms of the amount of CO_2 to which they would be equivalent in terms regarding their radiative forcing. Other authors consider just CO_2, concentrations i.e.the quantity of CO_2 alone as the most significant long-lived atmospheric GHGs. See also footnote 284. This makes research and authors' conclusions difficult to compare, although, as suggested in section 3.2 and an earlier footnote, it is in any case spurious to pose such equivalences; they can only be used a rough indication for relationships, and are all the more reason for precaution to be taken.
[285] http://www.esrl.noaa.gov/gmd/ccgg/trends/global.html
[286] Data from http://www.realclimate.org/index.php/archives/2007/10/co2-equivalents/ . The article highlights that there are two ways of defining "CO_2e". Either we calculate the combined effects of all forcings in terms of the equivalent CO_2 forcing (this is the former, "net" figure), or we tries combine just the Kyoto GHGs (the latter figure). The first includes substances that have cooling effects (e.g. from aerosols); the figure is therefore close to the CO_2 concentration level since at the moment cooling effects roughly cancel out non-CO_2 Kyoto GHGs. Whilst the CO_2e *net* metric more accurately reflects the current forcing levels, arguably the latter Kyoto GHGs levels should be assumed as the current level when setting precautionary emissions limits, since the proportion of coolants in the atmosphere is likely to decline and "net" CO_2e concentrations will move closer to the Kyoto GHGs CO_2e metric. (I am suggesting, for example, that if we decide to reduce to 350ppm CO_2e *net*, then we should still aim to limit just the Kyoto gases to 350ppm CO_2e).

Meinshausen[287] famously examined 11 climate sensitivity studies[288] to derive probability ranges of exceeding 2°C[289] in equilibrium[290]. Crucially, he found that an atmospheric concentration of 550ppm CO_2e[291] (previously a common policy target for limiting GMT rise to 2°C[292]) was between 63% and 99% likely to *exceed* 2°C. For a 2°C GMT limit, 550ppm CO_2e would, therefore, be far from a precautionary atmospheric concentration. Even at 450ppm CO_2e, Meinshausen found that there was between a 26% and 78% likelihood of exceeding 2°C. And at 350ppm CO_2e, the lowest concentration examined (and far lower than current concentrations), this still gives between a 0% and 31% likelihood of exceeding such a target. Meinshausen's 2006 study also examined the likelihood of exceeding a 1.5°C temperature target, and found a concentration of 450ppm CO_2e gives a roughly[293] 55% to 98% chance of exceeding 1.5°C, and 350ppm still gives approximately between a 3% and 48% likelihood[294] of exceeding it.

Taking a precautionary approach would, therefore, imply moving towards a stabilisation of about 350ppm CO_2e. This is confirmed by recent work suggesting that climate sensitivity could be higher than previously thought[295] and Hansen et al have argued that it could be substantially higher - 6°C rather than 3°C[296] - when slower feedback processes are taken into account[297]. This means that climate sensitivity is more likely to be towards the higher than lower end of the probability ranges considered by Meinshausen. In fact, Hansen et al, suggest that *current* atmospheric CO_2 concentrations (385ppm CO_2 in 2008[298]) are already likely to lead to an equilibrium GMT rise of 2°C, and therefore recommend an "initial target" of 350ppm CO_2[299]. Although specified in CO_2 rather than CO_2e, this figure effectively recommends a similar concentration level to Meinshausen's 350ppm CO_2e scenario, since Hansen et al assume that coolant effects balance out the non- CO_2 Kyoto

[287] Meinshausen, 2006
[288] These try to assign probabilities to the possible range of climate sensitivity (Meinshausen, 2006, p266).
[289] Other temperatures are examined, but less prominently.
[290] Although it is "not clear how fast the climate system reaches equilibrium" (p266)
[291] Meinshausen is looking at net CO_2e (Meinshausen, 2006, p266)
[292] See e.g. Stern, 2006, which focused on CBA of concentrations of 450-550ppm, although even this cited a 77-99% chance of exceeding 2°C at a 550pm CO_2e level.
[293] These figures have been read from the graph on Meinshausen, 2006, p272; Meinshausen was contacted but the original data was unavailable.
[294] See previous footnote.
[295] Anderson and Bows, 2008, p3864.
[296] Hansen et al, 2008, p218
[297] Hansen et al, 2008, p217
[298] Hansen et al, 2008, p221
[299] Hansen et al, 2008, p226

gases (and therefore that net CO_2e approximates the CO_2 level)[300] (see footnote 284). However, given that this approximation may not continue (e.g. if use of coolants decline), a 350ppm CO_2 level does not seem precautionary. Indeed, Hansen et al argue that "a case already could be made that the eventual target probably needs to be lower"[301] and at one point suggest 300-325ppm CO_2 [302][303]. This therefore suggests a move back towards the pre-industrial levels of 280ppm CO_2[304]. These implications illustrate my earlier suggestion towards the end of 3.2, that a precautionary approach requires taking a resilience-based perspective; that there is no "safe" level of emitting activity, and avoiding DACC instead requires preserving the ecological conditions and levels of functioning which have previously supported us. The question will be how far anything approaching this is possible to achieve; both physically, and socio-economically (in the sense that I described in section 2.4, without causing comparable harms).

Regarding physical possibility, although even Hansen et al's suggested 350ppm CO_2 limit is lower than current CO_2 concentrations, we may be able to stabilise at lower atmospheric concentrations and not reach the GMTs associated with higher temperatures because the relationships discussed above are between atmospheric concentration *stabilisation* levels and their *equilibrium* temperatures. Because it takes many centuries for the climate to reach the equilibrium temperature from a particular atmospheric concentration, reaching or passing an atmospheric concentration level should not mean its equilibrium temperature will also be reached, if concentrations are lowered fast enough and deeply enough. This is not particularly reassuring, since it is unclear exactly what the effect on transient (pre-equilibrium) GMT would be from such a temporary peak and subsequent lower stabilisation[305]. It is also not possible to immediately lower concentrations, even if all atmospheric emissions ceased today[306] because of the atmospheric lifetime of GHGs[307].

[300] Ibid.
[301] Hansen et al, 2008, p229.
[302] Hansen et al, 2008, p226
[303] The work of Hansen et al has been taken up through new campaigns for a "350ppm emergency pathway" - see Baer et al, 2009 and campaign group 350.org (www.350.org)
[304] The work of Harvey, 2007b implies similar conclusions.
[305] The effects on GMT rise are unclear in scenarios where atmospheric concentrations first peak and subsequently reduce. Although, due to climate inertia, we would avert the equilibrium temperature associated with the peak concentration level, we are likely to reach a higher GMT than otherwise likely from the lower concentration level. See Meinshausen, 2006, p271-272.
[306] Hare & Meinshausen, 2006, p126, in such a scenario, find that "CO_2 concentrations would fall slowly and approach levels that were found at the beginning of the 20th century towards the end of the 22nd century, namely 300ppm".
[307] Other than the possibility of removing atmospheric emissions using geo-engineering, which is as yet unproven and has its own risks and critics as I highlight shortly.

However, atmospheric concentrations can be brought down over time, although this requires steep global emission reductions, as I now briefly consider.

In so far as we set concentration targets, this will not, therefore, be according to a 'safe' level, since current atmospheric GHG concentration levels are already unsafe, but rather a question of how fast we are able to reduce emissions so as to bring atmospheric concentrations back towards more precautionary levels. I argued in section 2.4 that these possibilities should not be constrained by what is currently thought to be socio-economically possible, but considering the range of socio-economic modes of organisation that might allow for different possibilities of making a transition to zero-carbon societies. This might seem too radical; however, it should be considered that even stabilising at 450ppm or 550ppm CO_2e would require such deep and fast global emissions reductions that Anderson and Bows have argued that even this is not possible "without a sea change in economic orthodoxy"[308]. Anderson and Bows find that "stabilizing at 450 ppmv requires, at least, global energy related emissions to peak by 2015, rapidly decline at 6-8 per cent per year between 2020 and 2040, and for full decarbonisation sometime soon after 2050"[309], and that "Stabilization at 550 ppmv CO_2e... requires global energy and process emissions to peak by 2020 before beginning an annual decline of between 6 and 12 per cent"[310][311]. They argue that there is no precedent for emission reductions on this scale, and, as alluded to in chapter 1[312], remind us of Stern's assertion that "reductions of greater than 1 per cent have 'been associated only with economic recession or upheaval'" and that even "the collapse of the former Soviet Union's economy [only] brought about annual emission reductions of over 5 per cent for a decade"[313].

Similarly, Ackerman et al have produced several scenarios for reducing to 350ppm CO_2[314] by different future dates without allowing negative emissions[315], and for different climate

[308] Anderson and Bows, 2008, p3877
[309] Ibid. Their figures make assumptions about our ability to reduce non- CO_2 GHGs such as methane and nitrous oxide from food production. (p3869-3871).
[310] Anderson and Bows, 2008, p3878-9.
[311] Anderson and Bows seem to use "CO_2 e" regarding total forcing of Kyoto GHGs rather than as net CO_2 e forcing (they do not include radiative forcing from aerosols). Their figures for necessary reductions might therefore seem precautionary. However, their figures are still slightly optimistic, since neither do they take account of "non- CO_2 aviation emissions, evidence as to the reduced functioning of carbon sinks or other underestimated emissions sources". (Anderson and Bows, 2008, p3866-7).
[312] Chapter 1, section 3.2
[313] Anderson and Bows, 2008, p3878.
[314] NB CO_2 not CO_2 e.
[315] I.e. removing emissions from the atmosphere, as Hansen et al suggest (Hansen et al, 2008, p226-227)

sensitivities. For a climate sensitivity of 6°C (a more pessimistic, but therefore precautionary guide) reducing to 350ppm CO_2 by 2200 requires emissions reductions to 53.4% of 1990 levels by 2020 and 3.2% by 2050; to achieve 350ppm CO_2 by 2100 requires reductions to 3.1% of 1990 levels by 2020[316]. And Matthews and Caldeira have argued that in order to reduce atmospheric concentrations enough to "stabilise" the climate at either 1, 2, or 4 °C requires decreasing to "near zero future carbon emissions"[317] by different times this century. The question is, therefore, not whether a zero-carbon transition should occur, but how fast.

This recent work has other implications. What determines atmospheric concentrations is cumulative emissions (the total quantity of emissions released) from an emissions reduction trajectory rather than the final percentage reductions. In fact, more recently, climate science has shifted away from directly considering atmospheric concentrations. Because of uncertainties and complexities over the relationship between atmospheric concentration stabilisations and both equilibrium GMT and emissions levels[318], research has started focusing directly on the "better constrained"[319] relationship between cumulative emissions and the maximum GMT that could be reached [320] [321]. It is now increasingly suggested that policy targets should be specified in terms of cumulative emissions budgets rather than aiming to stabilise at particular concentrations[322]. There is not space to examine possible cumulative emissions budgets here. However, as an indication, the lowest budget considered by Meinshausen et al is 890Gt CO_2 (or 1356 Gt CO_2e) or lower between 2000 and 2050, which they suggest would give a probability of between 8 - 37% of exceeding 2°C[323]. By comparison, in 2010 we released 30.6 $GtCO_2$ [324]; if released every year between 2000 and 2050 we would almost double the 890Gt CO_2 budget. And given the precautionary approach I have been advocating and the need for GMT limits of lower than 2°C, a precautionary budget would be even less.

[316] To achieve 350 any earlier (2085) requires immediate 100% reduction (Ackerman et al, 2009, p44)
[317] Matthews & Caldeira, 2008, p1
[318] Allen et al, 2009, p1163
[319] I.e. with fewer uncertainties. Ibid.
[320] See e.g. Meinshausen et al, 2009.
[321] Allen et al, 2009 p1164. This leads them to define a new measure, "Cumulative Warming Commitment (CWC) as the peak warming response to a given total injection of CO_2 into the atmosphere", to replace both climate sensitivity and carbon cycle uncertainties (p1165). Matthews et al, 2009, define a similar measure, the "carbon-climate response (CCR)" (p829)
[322] E.g. Allen et al, 2009, p1163, Zickfeld et al, 2009, p16132, Anderson & Bows 2011, p21, New et al, 2011, p16
[323] Meinshausen et al, 2009, p1161
[324] Harvey, 2011.

Either way, however, what seems clear is that any of the above scenarios would require a massive global transition[325] to zero carbon. We must, therefore, seek ways to make reductions on this scale, bearing in mind the notion of "proportionality" discussed in section 3.4. That is, as argued in section 2.4, what is sought is a genuine transition that does not cause comparable harms, that aims to create both the ecological *and* socio-economic conditions for a society/ societies that can function and flourish into the future, even if (by virtue of need to reduce energy demand) material aspects of standard of living (i.e. consumption) are lowered. This will involve changes of the sort alluded to in 2.4, being pioneered at community levels by the Transition Towns movement, but which need to be taken up by governments to provide a regulatory framework and financial support, along the lines of what is suggested in the "Zero Carbon Britain 2030" report[326].

Because of concerns that even this may be inadequate, some authors have considered the possibility of negative emissions, i.e. removing CO_2 from the atmosphere using CO_2 air capture technologies or "improved agricultural and forestry practices" to "draw down CO_2"[327]. However, it is unclear how successful this might be, so others have emphasised that this must be *additional* to emissions reductions[328]. There is also significant controversy about the risks of some suggested approaches such as biochar[329] and the PP must be applied here too, with a view to proportionality, as discussed in section 3.4, i.e. that precautionary action should not itself risk comparable harm. Yet some approaches based in rebuilding ecosystems and carbon sinks that have been depleted should certainly be enacted, as suggested by Ernsting and Rughani[330].

Because most suggested emissions budgets/trajectories assume conventional economic constraints I cannot here advocate a particular emissions budget (this is a crucial challenge for future research; to look at how quickly a radical *global* transition to zero carbon emissions could be made, and what emissions budget could be adhered to). However, I

[325] Even Ackerman et al's 350 ppm CO_2 by 2200 scenario would require strategies of this kind since this requires global reduction to 20.9% of 1990 levels by 2030 (Ackerman et al, 2009, p44).
[326] Helweg-Larsen & Bull, 2007
[327] Hansen et al, 2008, p226-227
[328] E.g. New et al, 2011, p14-15
[329] See e.g. Monbiot, 2009, Ernsting & Rughani, 2008
[330] Ernsting & Rughani, 2008, p77-80.

conclude that an "ecologically effective" international agreement on DACC would roughly require a global mitigation plan that:

- Recognises that **any further GMT rise is harmful**, and constitutes dangerous anthropogenic climate change.
- Aims to and stands a good chance of preventing not only a 2°C GMT rise above pre-industrial levels, but **a GMT rise of above 1-1.5°C**.
- In as far as atmospheric concentrations are considered, aims to reduce atmospheric concentrations **at least to 350ppm CO_2e net forcing** (but towards pre-industrial levels of both CO_2[331] and other GHG concentrations[332]), as soon as possible[333] and aims for a cumulative emissions budget consistent with as low likelihood as possible of exceeding 1-1.5°C.
- Therefore **aims for a global zero carbon transition** as soon as is possible this century, *as well as* examining the possibility of negative emissions in so far as they do not pose additional, comparable risks.
- Recognises that **"as soon as possible" is dependent not merely on the limits dictated by current socio-economic structures** but by transitioning to other socio-economic models compatible with such changes, and without causing comparable harms to the socio-economic conditions for continued functioning and flourishing of our societies.

Because of the limits that will be imposed on economic growth under and after such a transition, this latter point is crucially intertwined with the second criterion of equity, which I turn to in the next chapter.

[331] I.e. *not* to rely on cooling effects from aerosols.
[332] Because, as suggested in an earlier footnote, they are *not* fully equivalent in effects, and reductions in one cannot necessarily be substituted by those of another.
[333] For anyone who still thinks this too radical, recall that a 350ppm CO_2e concentration still implies up to a 31% chance of exceeding 2°C and up to an 18% chance of exceeding 3°C; higher concentrations, e.g 400ppm give up to a 17-18% chance of exceeding 4°C, which would be utterly catastrophic. (NB figures approximate since read from graph in Meinshausen, 2006, p272)

CHAPTER 3 - Equity.

0. Introduction.

This chapter considers the second criterion for an international climate change agreement: equity. It may seem unclear why this should be important for an agreement. Given the urgency in limiting emissions as quickly as possible, why complicate matters with lengthy considerations of equity? It may in any case appear pointless to attempt to influence ethically negotiations that seem driven by power politics and competitions of interests, regardless of any ethical 'idealist' demands. However, it is worth recalling why many campaigners, lobbyists, and particularly developing countries[1] consider equity issues to be central to the issue of climate change mitigation. Once we treat the climate as a commons, as discussed in chapter 1, recognising the dangerous implications of these levels of emissions and limit their growth with an emissions cap, this creates a 'zero-sum game' for emissions considered as a resource. And, since emissions are tied to our economic systems, inequities in emissions distribution will be intertwined with wealth inequalities. The cap must be set so low – indeed, I argued in chapter 2 that we need a global "zero-carbon" transition - that these differences will have significant economic impacts. Equity then becomes a key issue for determining how to distribute the emissions space during the transition, to ensure it is "just"[2]. And if countries do not feel they are being treated fairly they may not commit to an agreement at all. So there are both moral as well as pragmatic reasons for considering the equity of an agreement to be central to our survival; as Aubrey Meyer has argued[3], "equity *is* survival".

There are further reasons why it should merit particular philosophical consideration. Many climate change proposals claim to exhibit equity, but what is meant by this is rarely examined, and even less frequently, given justification. If equity is to be required from an international climate change agreement, we must examine *how* it should be equitable, and why this is preferable to any other conception. As I argue in 1.2, one need not and should not be relativist towards alternative conceptions by resorting wholly to 'fair process' to decide between them[4]. Rather, we should debate explicitly what constitutes an ethically

[1] See Najam et al, 2003
[2] TUC, 2008.
[3] Meyer, 2000, p17.
[4] Although, of course, the process for international negotiation itself *should* be fair.

defensible equitable distribution of emissions, a debate which will have a role to play in influencing policy positions.

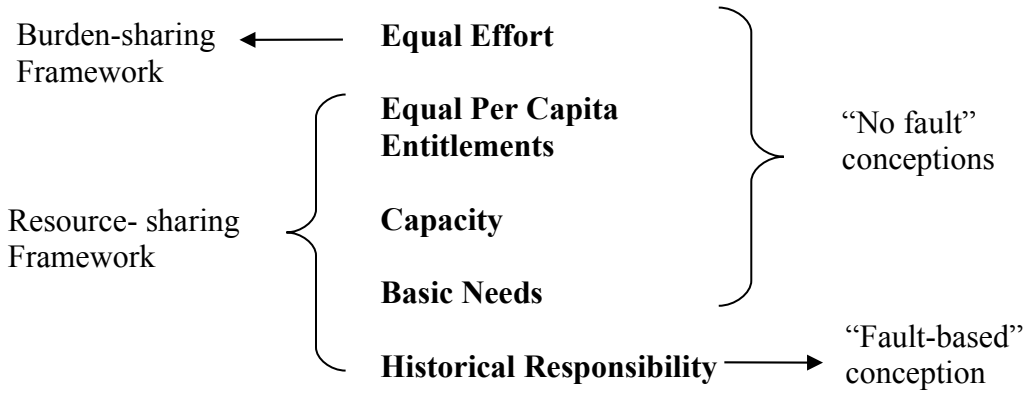
Accordingly, in sections 2-5 I scrutinise four of the five main contending conceptions of equity for climate change mitigation that have been put forward, as summarised by Ashton and Wang[5]. These are what Shue has termed "no fault" principles[6]: Equal Effort, Equal Per Capita Allowances, Capacity, and Basic Needs (see fig. 6 for theoretical groupings). I draw on philosophical literature on equality and distributive justice, which has only recently begun to be applied to the climate change debate[7]. I have considered the fifth, Historical Responsibility, as a fault-based conception elsewhere[8].

Section 1 considers and clarifies some methodological concerns about the scope and nature of distributive equity in this context. In Section 2 I examine the problems with Equal Effort as a principle of equity for mitigation policy, which, I argue in 2.2, fails to understand equity within the context of ecological limits – as resource-sharing as well as *just* burden-sharing. The resource-sharing framework is the appropriate starting point for principles of distributive equity which arises from the pre-analytic vision of green economics as outlined in part C of chapter 1, and underlies only the remaining three conceptions of equity which I consider in sections 3-5. (see fig.6)

In sections 3-5 I argue that, despite the intuitive appeal of "Equal Allowances", the principle of "Capacity", interpreted through a capabilities approach[9], is the most ethically defensible conception of distributive equity. The first four principles constitute what Shue has called 'no fault' principles[10], in that they do not try to take account of moral responsibility (see fig. 6.). The fifth, "fault-based" principle, Historical Responsibility, whilst ethically appealing, is only egalitarian in so far as it is inextricably linked to Capacity. I have argued this elsewhere[11], and summarise my arguments in the conclusion of this chapter.

[5] Ashton & Wang, 2003, p3-5
[6] Shue, 1993, p51-2,where a 'no-fault' principle assigns obligations to a party to pay or contribute (e.g. based on capacity), but any "past misbehavior" is not accounted for. A fault-based principle on the other hand, is "based precisely on fault or causal responsibility", although "The kind of fault here need not be a moralized kind".
[7] E.g. Ashton and Wang, 2003; Singer, 2006; Brown, 2002, p206-207; Page, 2008; Starkey, 2008
[8] Makoff, 2011.
[9] As put forward by Amartya Sen in Sen, 1979 and 2001
[10] Shue, 1993, p52
[11] Makoff, 2011

Fig. 6: Principles of Equity



This chapter assumes a global emissions "cap", which rapidly descends (e.g. annually) over time towards zero (i.e. a global zero-carbon transition), and which can be distributed between countries.[12] However, I will not refer to exact figures, or the level of the 'cap'[13], since I consider predominantly the principles on which an equitable distribution might be based. Likewise, I do not discuss intergenerational equity, since, as discussed in chapter 2, this is best considered an aspect of ecological effectiveness, affecting the total size of the cap, rather than how we distribute emissions within it (in so far as it is appropriate at all for intergenerational moral relations[14]).

1. Methodology; Scope of research, definitions, and structure.

1.1 Scope of equity concerns.

I firstly clarify some questions of scope based on four areas of concern for equity in DACC mitigation that Henry Shue highlights[15], so as to avoid potential confusion as to the particular focus on equity of this chapter. However, I believe these areas of concern are

[12] The chapter assumes that we will distribute this budget on a 'nation-by-nation' basis. There is a case for other means of distribution that by-pass nation states, for example, through upstream auctions of permits. However, it is not clear how these would meet the demands of international equity; these warrant consideration, although there is not space to do so here.
[13] See Chapter 2, section 4
[14] See Chapter 2, section 2.3
[15] Shue. 1993, p40, also called "domains of choice" by Ashton and Wang, 2003, p6

best expressed as three sets of distinctions, since some cut across others[16]. These are; between equity in mitigation and adaptation[17]; between equity in procedure[18] and distribution; and lastly, between equity in distribution of emissions themselves[19] and distribution of costs through resource-transfers[20] for reductions.

Although the questions of equity in adaptation and equity in procedure are extremely important, I do not address either here[21]. My focus is on equity in climate change *mitigation*[22], and I restrict my focus to the distributive concern: regarding the content of the outcome of the negotiations that should be pushed for. Of course, there are links between procedural and distributive equity, as well as between mitigation and adaptation; regarding the latter, as Shue points out, the commitments a country will have under one may influence its ability, or its obligation to make commitments in the other. However, these questions are beyond the scope of this thesis. It may be, therefore, that my conclusions surrounding equity in mitigation would need revising once these other areas have been examined in a similar way elsewhere.

Regarding the last distinction, between the distribution of emissions allowances (which limit the ability of each country to produce emissions), and the direct distribution of the *cost* of reducing to these emissions limits, I focus in this chapter on the former. To clarify the distinction; although it may seem that equitable distributions in both could coincide, there may be reasons to suppose that they should come apart. For example, it might be

[16] E.g. one can consider equity in mitigation in terms of procedure or distribution; similarly, distribution of costs might relate either to equity in mitigation or to adaptation.
[17] Equity in adaptation is Shue's second question of equity. This is related to the underlying inequity in the effects of climate change; that the burdens and benefits of DACC impacts (some of which we are already committed to from past emissions) will be very unequally distributed across the globe. Whilst we cannot alter this distribution, we can alter the distribution of the costs in responding to these impacts.
[18] Procedural equity is Shue's third question of equity. This surrounds fairness in the process of negotiations, such as whether all countries have equal numbers of delegates, equal training opportunities or political weight. Inequities here have historically lead to the concerns of poorer countries being overlooked, with only a handful of trained delegates who are often kept out of discussions. Shue, 1993, p47
[19] Shue's fourth question of equity
[20] Shue's first question of equity. I take this to be distinct from the 'burden-sharing framework' as described in 2.3, which still considers emissions as what will be distributed (even if it focuses on the 'burdens' of emissions reduction as opposed to the end allocation); whereas equity in cost distribution I assume to refer to the *financial* costs associated with emission reduction (or with adapting to a particular allowance).
[21] Though this is somewhat regrettably the case – it seems clear to me that this is an area of research greatly overlooked in general and in need of ethical scrutiny.
[22] Unlike, e.g. Caney, 2005, who considers the more general "burdens of climate change where the latter is silent on the choice between adaptation and mitigation"(p752). However, I think it important to treat mitigation separately, in recognition of this aspect of climate change as a particular problem of distribution of emissions space in the global atmospheric commons, and in consideration of the socio-economic relevance of emissions, rather than treating all climate change "burdens" as equivalent.

argued that countries A and B should have equal access to atmospheric space and both limit their emissions to 10 units. But country B may find it harder to limit its emissions if it is significantly poorer than A. One could then choose to argue that their total costs for the emissions reductions should be borne largely by country A, say on a 3:1 split, with A meeting half of the costs for B's emission reductions through finance and technology. This might be achieved through an equitably funded/accessed climate mitigation fund, or through tradeable emission permits.

For simplicity I focus in this chapter on distribution of emissions themselves, rather than the associated costs, although I suggest in section 4 how "Capacity" might be accommodated through a combination. I return to the idea of tradeable permits in chapter 4, as a means often proposed of promoting 'efficiency' in emissions allocations, whilst allowing equity to be promoted through distribution of costs, but which I regard as problematic. However, I will generally treat equity in 'distribution of mitigation costs' as a policy variation (i.e. instead of or as well as distribution of emissions) which would require separate consideration over how far it could meet the objectives I argue for here.

A few further points of clarification. Although as suggested in chapter 2 section 4, mitigation efforts must include protection or enhancement of sinks as well as emissions reductions, for simplicity I narrow my distributive focus to emissions reduction, because of the further (including very technical) complications that would be raised by consideration of sinks, and their unequal distribution. I also consider emissions reductions in this chapter as though they were one magnitude, although, as emphasised in chapter 2, there are different GHGs and each cannot be made exactly equivalent because of uncertainties over their respective atmospheric lifetime and radiative forcing strength. It may be that my approach to equity could be applied separately for each greenhouse gas, although this could make their application very complicated. Additionally, I do not consider here how equity should be applied within countries. Whilst there are important concerns of national equity in emissions space, it is a further question how far an agreement should specify each nation's use of its national emissions allowance, and my discussion here makes no assumption one way or the other.

Lastly, it might be asked whether the task of evaluating an equitable distribution of emissions to a climate change agreement is not hampered *prima facie* by the kinds of

criticisms made against the notion of global justice[23]. That is, that the ethical considerations of the "equality of what" literature that I draw on are (allegedly) relevant only at a national or community level, and cannot be simply writ large to the global scale. But this objection is premised on a 'social contract' understanding of justice which ignores the significance of globalisation and, more importantly, the existence of global commons. One can legitimately debate morally preferable principles of equity to guide a global climate change agreement without committing oneself to a wholesale liberal cosmopolitan view of global justice (which would include issues like citizenship, the role of the (global) state, political liberty and distribution of entitlements). I do not propose or consider here any theory of global justice or assume the need for a global social contract. I examine the 'equality of what' literature as a way to understand interpretations of 'equity' as a guide to moral relations between people in the world as a whole, since such distributive issues have clearly arisen. Sen has made a similar point, countering Nagel's belief that "In the global context" in the absence of a world government, the "demands of justice" are inapplicable and we should concentrate instead on "minimal humanitarian morality". This ignores, Sen argues, that "When people across the world agitate to get more global justice... they are not clamouring for some kind of 'minimal humanitarianism'. Nor are they … agitating for a perfectly just world society"[24].

1.2 Definition versus moral content: What do we mean by 'equity'?

I now consider what is and should be meant by 'equity' in this context. Why, in the first place, should this not be replaced simply by the term 'equality'? I interpret 'equity' in the distributive case, as 'fair equality', or 'removal of unfair inequality'. For 'Equality' itself may not always relate to morally relevant features. Firstly, since some forms of equality might not be thought to be justified (one could, as I explore during the chapter, choose to equalise effort, resources, welfare, etc, and not all might be thought fair). Secondly, because there are sometimes inequalities in our given value that might be thought to be fair – because they are, for example, as a result of human choices. And lastly, because equity may take on a prioritarian guise. It may aim, for example, to meet basic needs, and may

[23] E.g. Nagel, 2005.

[24] Sen, 2008, p340-341. Pogge similarly argues that advocating global justice need not depend on a "strong cosmopolitan" position (Pogge, 2002). He justifies extending a Rawlsian difference principle to a global level (Pogge, 1989 section 23.2) because we do not belong to "closed, self-contained societies"; our lives are "profoundly shaped and affected by events reverberating through an international scheme of trade and diplomacy" (p263).

not, strictly speaking, seek to equalise anything[25], yet prioritarianism is typically seen as a form of egalitarianism[26].

Since various conceptions of equity exist, it has been argued that a specific definition of equity is not possible[27]; it is a 'dialectical' rather than 'analytic' concept[28]. This is particularly clear with regards to climate change negotiations, where Ashton and Wang argue that "Competing parties champion different notions of equity, not surprisingly those coinciding most closely with their interests"[29]. These are, (Historical) Responsibility, Equal Allowances, Capacity, Basic Needs, and Comparable Effort, and together they argue, they can be taken as "dimensions of equity" to "define a notional 'equity space'" [30]. However, there is an important distinction between defining the *concept* of equity, and advocating a particular *principle* of equity (and its appropriateness for a particular context). I want to distance myself from the kind of approach subsequently taken by Ashton and Wang with their treatment of these "dimensions", which seems to conflate this kind of concept-conception distinction (as understood by Rawls[31]). For, they see their definitional task not simply as defining equity through looking at use of the term, but further, in 'discovering' the moral content, assuming that each, (for them) subjective dimension is equally morally valid.

They want to "understand the essence of equity, uncluttered by other self-interested considerations"[32] through examining the different "dimensions" of equity, as though there were some hidden moral unity between them. But, since they also argue that one *cannot* decide between these "dimensions"; some of them are "competing", and "lead in different directions", they conclude that, "*There is no single objective way to reconcile them or to calculate tradeoffs between them*… We need to allow space for the politics to arrive at a rough balancing of competing equity demands"[33]. Thus their methodological approach embodies a moral relativism with regards to what are, for them, equally valid "dimensions"

[25] For a fuller definition and discussion see section 5.2
[26] See Parfit, 1995
[27] E.g. Ashton and Wang, p3; Rose and Stevens, 1993, p118
[28] Daly, 1997, p2 ; Dialectical concepts have "evolving penumbras which partially overlap with their "other".", but with "analytical concepts... the law of contradiction holds".
[29] Ashton & Wang, 2003, p3. Schelling and Cooper also make this point, cited in Goulder and Nadreau, 2002, p121
[30] Ashton & Wang, 2003, p3.
[31] Rawls, 1972, p5-6
[32] Ashton & Wang, 2003, p3
[33] Ashton & Wang, 2003, p13

of equity, which leaves the demands of equity to be 'balanced' by political process, rather than scrutinised by ethical consideration. Whilst I agree that each 'dimension' could reasonably be said to fall under (and together 'define', in a fuzzy sense), the concept of equity, we still can – and should - argue for a particular 'dimension' as a justified conception / principle of equity, rather than aim simply to achieve a 'rough balancing'. They err, I believe, in supposing that the variable but legitimate use of the term equity in language – the 'equity space' – must also commit us to moral content. Brown has argued, similarly, that "the lack of consensus of what equity means under the UNFCCC does not mean that any proposed operational definition of "equity" is entitled to respect as a matter of morality."[34]

It is not, therefore, necessary to conclude like Ashton and Wang that determining the content of equity must rely on political negotiation to 'balance' the associated competing interests (although in practice politics has a significant role to play), as a form of procedural arbitration[35]. And, if the decision to choose between competing principles is thus left wholly to 'politics', assumed to be driven, as Ashton & Wang argue, by particular interests, the outcome would be a result of "raw power"[36], reflecting the current interests of countries wielding the most influence at the negotiating table. Rather, "The better way to proceed is to first make proponents of various definitions of equity demonstrate how their criteria for equity comports with acceptable moral principles.... Only those definitions that survive this ethical analysis should be the subject of ethical compromise."[37]. That is, as Brown and others[38] have emphasised, it should be understood as an ethical enquiry. One can explicitly argue and debate the different conceptions *as* principles, and consider the grounds for each as appropriate in this particular context, in order to decide which option is worthy of support; an approach that not considered by Ashton and Wang. And, surrendering discussion to political negotiation rather than ethics could threaten the

[34] Brown, 2008
[35] They conclude this in the absence of an "objective" calculation of trade-offs to "reconcile them", which they view as the only other alternative to relativism. But to even imagine that this is possible treats conceptions/principles of equity as equivalent to tastes or preferences in the neo-liberal marketplace, where (following the principles of rational choice theory) choice is grounded on a trade-off between individual preferences, all seen as commensurable, whether the so-called "preferences" are ethical positions, needs, or tastes
[36] Brown, 2002, p206
[37] Brown, 2008
[38] E.g. Baer, 2002

likelihood of an agreement, since, as Brown argues, "no global consensus is likely to emerge on national allocations unless nations perceive that global allocations are fair"[39].

But what is the role of the ethical discussion of equity here in this wider context? After all, political interests will, in practice, be highly influential over the outcome of negotiations. My suggestion is, along with Brown, Baer and others, that the ethical discussion must play a part of the decision-making process[40], as it is already for activists, NGOs, and some voters and politicians. If grounds for competing principles are examined and certain conceptions of equity argued to be unjustifiable, it will be much harder for the associated 'raw' interests to dominate in the face of public scrutiny, and especially given the need to be seen to reach a fair outcome.

I therefore follow Baer in focusing on the fairness of principles "not because I believe that it is better to be morally righteous than to be practical but because what a government and its citizens believe is fair is one justification of country's [sic] negotiating positions"[41] "The analyst" in an "ethical analysis", as Baer argues, "is a participant" in the debate "and equity is something to be defined and argued for in order to influence the world"[42]. The terms of debate in academic policy circles can be shifted, and this is literature which can have some influence both for policy-makers and their researchers, but also for lobbyists, campaigners and pressure-groups who may still be uncommitted to particular policy proposals. Of course, the formulation of the principle of equity I argue for in this chapter represents an ideal which may be too strict in practice. The end negotiation will be a result of compromises which take account of the (current) limits of political possibility as well as other practical and ethical concerns (surrounding, e.g. 'national sovereignty') and disagreement over the demands of equity. But it is still important to try to define this ideal to guide political decision-making as far as possible.

To this end, I next consider four of the five "dimensions of equity" highlighted by Ashton and Wang as possible interpretations for a principle of equity in a mitigation agreement. They will be examined in the following order - Comparable Effort (section 2), Equal (per

[39] Brown, 2002, p206
[40] Baer has also criticised authors who "suggest possible allocation formulas that they believe could be acceptable to all parties" because "the interests and preferences of countries are taken as given" Baer, 2002, p395
[41] Baer, 2002, p398-9
[42] Baer, 2002, p395

capita) Allowances(section 3), Capacity(section 4) and Basic Needs (section 5) [43]. There are some alleged conceptions of equity that do not stand up to even minimal ethical scrutiny, which I will not consider in any depth here. I assume that equal distribution per country (which does not allow for population size) is self-evidently unfair[44]. I also ignore a further possible principle of equity suggested by another PEW paper[45], 'opportunity for reductions', which does not seem to constitute primarily a principle of equity, but rather a principle of efficiency[46], understood as differences in "the number and cost of opportunities to reduce greenhouse gas emissions… the energy intensity of an economy"[47]. Although linked to equity (in that countries emitting inefficiently are using more emissions space that could otherwise be allocated elsewhere), I turn to this idea in chapter 4, where I consider 'efficiency', but understood in the context of ensuring equity and ecological effectiveness.

2. Comparable Effort.

2.1. The moral relevance of effort

The idea that equal 'comparable effort'[48] should be understood as a principle of equity for a mitigation agreement has been associated with the position of the United States[49]. The suggestion is, as Ashton and Wang describe, that "In assessing whether an outcome is equitable, parties will invariably compare the effort they are being asked to make and that required of other parties… if some parties seem to be getting a better deal from others – if their commitments are, in some sense, disproportionately easy – the deal may still be denounced as unfair"[50].

[43] Taken from Ashton and Wang, 2003, p3-5, also considered in a similar form in Vattenfall, 2006, p23. The order of consideration is mine.
[44] Even if there are concerns about allowing *entirely* for population size (because of concerns this could incentivise larger populations), *not allowing at all* for population seems obviously wrong, because it would allow a country the size of Luxembourg the same emissions allowance as a country the size of the United States.
[45] Claussen & McNeilly, 2000, p14
[46] Brown makes a similar point in Brown, 2002, p216.
[47] Claussen & McNeilly, 2000, p18.
[48] Sometimes known as 'comparable burdens'
[49] Baer, 2002, p395
[50] Ashton and Wang, 2003, p5.

This is the kind of criticism launched by the US against the Kyoto Protocol, because of the lack of commitments for developing countries, and supposedly unfair higher burden in emissions reductions placed on industrialised countries[51]. What might constitute an 'equal effort' for this kind of position is typically understood as emissions reductions requiring an equal percentage of each country's GDP to implement[52]. This will also approximate to 'grandfathering' (equal percentage reductions based on "prior use levels"[53]), since "if all countries are required to make the same percentage reduction in their emissions, and if emissions are roughly proportional to income, then everyone will face roughly the same costs relative to their income"[54]. Although this 'comparable effort' approach is often met very sceptically by activists because it typically allows higher emitting countries to continue emitting at higher levels than others, it is important to clarify where the inequity lies.

Why might effort be relevant? For, at first glance, the idea that countries should make an 'comparable effort' might seem reasonable as a principle of equity, in implying a principle of equal sacrifice – that we should share burdens equally in face of our common global danger[55]. One concern, however, is why such effort[56] should be morally relevant, if, given the existing unequal emissions distributions, the outcome may be similarly unequal. It seems fair that if a society expects equal effort from its members, they might also expect that an equal 'reward' be received from this effort – these are the kind of practices that are promoted in a meritocracy, and certainly by liberal egalitarians, who consider that outcome should be in proportion to effort alone[57] (and would vary with it, so that equal efforts receive equal returns). But these are in cases where all else is equal. In the case of emissions reduction, however, not all else is equal – we start, as has been said, from a

[51] This was expressed in the "Byrd-Hagel" Senate resolution adopted in 2007 (Meyer, 2000, p63-64), which, as Meyer points out, is in fact consistent with the "Contraction and Convergence" policy proposal, based on convergence to equal per capita allocations, even though previously the US had argued for national equal percentage reductions.
[52] Brown, 2002, p207.
[53] Definition of 'grandfathering' from Brown, 2002, p209
[54] Baer & Athanasiou, 2007a, p16.
[55] Baer, 2002, p395
[56] I assume for the moment that such effort *would* be equal – but I return to this shortly.
[57] E.g. Cohen, 1989, p914 who reads John Rawls as arguing in *A Theory of Justice* that "not all effort is deserving" because it is "influenced by" ones "natural abilities and skills and the alternatives open to him" whereas what matters is effort that is wholly a result of personal responsibility. He continues on p916 to say that the "purpose" of egalitarianism "is to eliminate *involuntary disadvantage,* by which I (stipulatively) mean disadvantage for which the sufferer cannot be held responsible, since it does not appropriately reflect choices that he has made or is making or would make". See also Dworkin, 1981b, p304-6.

position of unequal emissions, so the 'reward'[58] of emissions a country is allowed to emit will be very unequal. From this perspective, 'effort' can not be considered as morally relevant until other morally irrelevant factors – i.e. factors that are not a result of choice or responsibility - have been eradicated, including, in particular, previous/current unequal emissions distribution, which can be taken as a 'given' prior to effort being taken [59].

If effort is to be a morally relevant dimension of equity for mitigation, supporters of an 'equal effort' principle will therefore need to argue that the existing distribution of emissions is fair(or irrelevant) and that the unequal outcome rendered by 'equal effort' is just. I suggest that the only option open to them at this point is to depart from a liberal-egalitarian approach to justice and embrace the kind of libertarian argument offered by the Lockean-Nozickean story[60]. That is, that 'end-patterns' are not the relevant objects of fairness, and judgement should instead be passed on the fairness of resource 'transactions' themselves so long as the resource in question was justly acquired at its origin.

But in this case, 'equal effort' is no longer a clear conception of distributional equity. There is a loose sense in which it could be, if the definition of justness for the "original acquisition" of a resource as property, which Nozick has termed the "Lockean proviso"[61], is considered to be a form of distributional justice. Locke famously states that a man [sic] can take as property all that, through labour, he "removes out of the state that nature hath provided" so long as "*there is enough, and as good* left in common for others"[62]. If this requires a form of initial distributional justice, then it might be considered a possible grounds for 'comparable effort' as a conception of equity for mitigation.

However, if interpreted in this way, the condition will not be met in the case of emissions distribution (even aside from other concerns about this kind of approach to justice) if the current distributional arrangements are preserved, as I now explain. The 'initial

[58] Although I am not suggesting that emissions allowances should be seen as a 'reward' – they are, however, presently, useful.
[59] In so far as these *are* a result of relevant choice and responsibility, they would constitute arguments for an *inverse* relationship between emissions level and burden of reduction because the choice to emit more emissions is a choice in the wrong direction – what we would reward, presumably, is choices for lowering emissions. This relates, therefore, to the principle of historical responsibility which I consider in Makoff, 2011.
[60] Donald Brown has also noted the Nozickean approach as a theoretical grounding for grandfathering of emissions.(Brown, 2002, p210)
[61] Nozick, 1974
[62] Locke *The Second Treatise*, chapter 5, para 27, in Laslett, 1960, my emphasis.

acquisition' can reasonably be understood as the distribution of emissions at the point of an agreement[63]. This is because the distribution up until the point of an agreement was not based on a restriction of total emissions - anyone could emit any quantity (setting aside for the moment the very real political, socio-economic and ecological barriers to so doing). As soon as restrictions on total quantity come into place, whatever distribution is determined will then be fixed as a country's allowance, as an appropriation akin to the process of initial acquisition, where land is removed from use by others[64]. An international agreement to limit emissions *is,* then, in this sense, the 'original acquisition'. But, therefore, the Lockean proviso is not then met if current unequal emissions distributions are preserved through, for example, distribution according to equality of effort (as it has been interpreted so far). Because in this case, it would not be true that "enough and as good" is left for other countries – in this zero-sum game, if one country is allocated an allowance equivalent to 20% of total emissions capacity, the other 202[65] cannot all access this same quantity.

Against the second part of this argument, one might highlight Richard Starkey's point that for right-libertarians, the term "enough and as good" is not interpreted in this sense. Starkey cites Narveson's claim that the Lockean proviso only requires that we should "not interfere with what others *already have*"[66] and Nozick's view that, even if this is not the case, appropriation is acceptable if those that lose out are compensated through being provided with work by the appropriators. But in this case it is clearer that to adopt such a view would involve a move away from a position of distributional equity altogether and towards a different approach to morality which would reject the inclusion of equity as a criterion altogether. As Parfit has argued, Nozick rejects "the ethics of distribution" altogether; for Nozick, resources are "not up for distribution… they are goods to which particular people already have entitlements, or special claims"[67]. I will not attempt to analyse such a position, since my task here is to consider conceptions of distributional equity, rather than argue for the basis of equity itself. But it seems clear that if 'comparable

[63] I differ here from Richard Starkey's consideration of the Locke-Nozick story with regards to emissions; he assumes that "the right-libertarian approach can most easily be framed in terms of [prior] ownership of fossil fuel, something straightforwardly amenable to private ownership", Starkey, 2008, p21
[64] This is not, however, to imply that such a process creates property, or that permits should be considered as such (see chapter 4, footnote 40). I mean only to imply that the cases are analogous with respect to fixing a quantity of a natural resource as usable by one party that was previously available to others.
[65] Assuming 203 countries in the world.
[66] Naverson, cited in Starkey, 2008, p12,
[67] Parfit 1995, p82.

effort' relies on this kind of interpretation to justify unequal outcomes, it cannot be considered as a valid conception of distributional equity.

2.2 Comparing effort

However, supporters of 'equal effort' might still argue that even if effort is not the overriding dimension of equity, it is still of *some* relevance, and must be balanced against other 'dimensions'. Ignoring equality of effort might be argued to lead to other kinds of unequal outcomes. Ashton and Wang, for example, argue that there might be concerns of 'competitiveness'; "Any regime that puts some countries under tighter carbon constraints than others alters the terms of trade and conditions for investment between them"[68]. But concerns such as 'unfair competitiveness' only take hold when the understanding of 'effort' is particularly narrow. Once more, it ignores the initial emissions of each party, and, accordingly the different *kinds* of effort each country would have to make. For, as Claussen and McNeiily highlight, "given that everyone does not start from the same place, the additional effort required on the part of some countries and the lack of effort required by others clearly would not indicate a fair strategy"[69]. This is analogous to arguments for progressive taxation – advocates do not believe that the same rate of taxation should apply to all income levels, because for those on lower incomes the burden arguably has a more significant effect on their lifestyle[70].

If effort is thus to be compared qualitatively, one needs to consider initial levels of emissions use and the uses of emitting activity, as Shue does[71]. But this wider interpretation of 'comparable burdens' then requires moving from considering equitable *reductions* alone to towards a focus on emissions *allocations* and their relationship with standard of living, either through principles of 'Equal Allowances', 'Capacity' or 'Basic Needs' which I return to in sections three, four and five. These two subtly different perspectives have been noted by Paul Baer. The *"burden-sharing framework*" sees the

[68] Ashton and Wang, 2003, p9.
[69] Claussen & McNeilly, 2000, p12.
[70] This point has also been made by Robin Attfield: "[the Comparable Burdens Principle]… is objectionable on the same grounds of justice as proposals to tax individuals in direct proportion to their income; for those people with little or no disposable income still have to contribute the agreed proportion, despite not being able to afford it. Similarly countries obliged to reduce their emissions to a fixed proportion of GDP would be obliged to deplete their economies and forego use of available resources, even if these resources could instead have been used to provide for the unsatisfied needs of their populations." Attfield, 2008, p3.
[71] Shue, as considered in section 5, distinguishes between 'luxury' and 'survival' emissions. Shue, 1993.

costs of global emissions reduction as "a burden that must be shared globally…In this framework it makes sense to say that the burden should be shared equally unless there are compelling reasons why it shouldn't be"[72]. But the alternative, "resource-sharing framework" begins by considering the "finite... atmospheric space", or global common resource (as defined in chapter 1, section 6), and asks how that resource should be distributed, and "whether a person or country has received or will receive a fair share of the benefits".[73]

This distinction should not be overstated, since, as Baer's later approach shows, it seems reasonable to combine the frameworks. For example, Baer's later advocacy of a combined Capacity and Responsibility conception of equity is framed as "effort-sharing"[74], but the "effort" is clearly also understood in the context of diminishing emissions space[75]. What seems problematic is an exclusive focus on burden-sharing without consideration of the commons-sharing context. This ignores "the disparity between the average American who emits just under 20t of CO_2 per year while the average Indian emits less than 1t and the average Chinese about 1.3t" but overemphasises "[the disparity] between a US that is required to reduce emissions and a China that is not"[76]. It can then be claimed that "Equal percentage reductions *perpetuate inequities* by allowing countries with historically high levels of emissions to continue releasing a disproportionate share of total pollutants".[77]

I now consider the three further principles of this chapter which all start from this resource-sharing perspective. However, this is not to suggest that all principles that embody such an approach are equally defensible. Indeed, the first, most straightforward of these, equal (per capita) emissions allowances, is not as equitable, I will argue, as it might intuitively seem.

[72] Baer, 2002, p 395
[73] Baer, 2002, p396. NB: Baer makes these points to explain why we should consider historical responsibility as a principle of equity. I do not consider this principle in this thesis, however, the same arguments that Baer makes here apply equally to the other three principles that I consider in this chapter; Equal Entitlements, Capacity and Basic Needs.
[74] Baer et al, 2008, p28
[75] Baer et al, 2008, p27-28
[76] Najam et al, 2003, p224
[77] Soroos, 1998, p33. My emphasis.

3. Equal allowances – can they be inequitable?

3.1 The problem with equal allowances

Under Equal (per capita) Allowances (EPCAs) the global yearly emissions budget would be allocated to countries on an equal per capita basis – i.e. depending on their population, on the basis of every person having an equal share[78]. Justifications tend to appeal to the idea of 'global emissions space' as a shared commons resource, and imply that dividing this resource equally between people who use it follows directly on. Peter Singer, for example, says that EPCAs are a "a self-evidently fair way to divide a common resource"[79]. Similarly, Donald Brown argues that they are "based on the notion that every human being has an equal right to use the absorptive capacity of the global commons"[80]. I describe this as embodying a strict 'equality of resources' view – (not to be confused with Dworkin's version of equality of resources, which I discuss later).

This relies on the assumption that the equal moral worth of all humans translates into an equal right to use resources. However, whilst it might seem more equitable to allocate emissions allowances on an equal per capita basis than, for example, by giving each country a quantitatively equal allowance (but not allowing for differences in population size), it is not self-evident that this is nonetheless the most equitable way to allocate a commons resource. For it is emphasised in Green Economic approaches that the value of resources lies in what they are used *for* and how they are used, rather than in possession of the resource itself[81]. Equalising the distribution of the resource may then mislocate the value that it holds. This concern is supported by much of the philosophical literature on equality of the last 30 years – in particular the so-called "equality of what"[82] debates. Richard Starkey has highlighted that "There is widespread agreement" that the

[78] This is most famously advocated in Meyer's "Contraction and Convergence" framework (Meyer, 2000).
[79] Singer, 2006, p419
[80] Brown, 2002, p158
[81] E.g. Scott-Cato, 1999, p45, for whom income and wealth function as means to meet our needs. See also Daly's critisms of fetishism of economic growth and its assumption of "infinite wants" rather than "absolute needs" (Daly, 1993a, p17-24 and p40-44).
[82] Sen, 1979

"appropriate equalisandum"is "not resources"[83] (i.e. what should be equalised[84]), because equal resource possession does not lead to equal welfare[85].

In the next section I shall outline why this is the case, before explaining why one apparent exception, Dworkin's version of equality of resources[86], will lend no more support to this than any other position on equality.

3.2 Welfare versus resources

I first examine briefly the main concerns of the 'equality of what debates' on welfare versus resources. This will enable me to clarify in 3.3 why none of the main positions of this debate, including 'equality of resources' will justify an EPCA position. A useful formulation to consider here[87] is "A uses X to do Y" where A is a person, X is the resource, and Y is the ends for which the resource is used. What we choose to equalise (henceforth, the 'equalisandum'), whether it is X or Y, makes a difference because the relationship between A, X and Y changes from person to person. I suggest that the reasons for this fall into two categories[88]:

i) Differences in how far a given Y can be achieved from a given X

People's circumstances can vary for reasons beyond the control of the individual (which are reasons generally agreed to be morally relevant[89]). These 'background' conditions can

[83] Starkey, 2008, p28
[84] Page, 2006, instead uses the term "currency of justice", p51
[85] Starkey examines the "equality of what" literature in relation to equity in climate change mitigation, although predominantly at the national, rather than international level. However, his main arguments against equalising resources are still relevant internationally. See my comments on applicability of distributive equity to a global level in section 1.1. Page, 2006 has also extensively reviewed this literature, although he considers it primarily with regards to *intergenerational* equity (other than parts of the concluding chapter); see my concerns about the intergenerational equity metaphor in chapter 2, section 2.3. However, I draw from Page where relevant.
[86] Dworkin, 1981b
[87] Formulation adapted from Thomson, 1987, chapter 1, as used to discuss 'needs'. I owe this point to Dr Ed. Anderson.
[88] i) and ii) are my own summary of the main relevant concerns in the literature as to the preferred 'equalisandum', based on Arneson 1990, Cohen, 1989; Dworkin, 1981a & 1981b; Clayton & Williams, 2002; Sen, 1979 and Starkey, 2008.
[89] There is a further debate in the literature on equality which I do not examine here (although I allude to it in 2.1, footnote 57), regarding how to best reflect the (assumed) intuition that people should be held morally accountable for their choices and that resulting inequalities should not be compensated for. This can also influence one's choice of equalisandum, including whether it is framed in terms of opportunity for or outcome for (resources, welfare, etc), depending on how one makes the 'cut' that defines when an inequality

arise from external circumstances or because of differing abilities, so that even with similar goals, more resources are required for the same ends. For example, a pregnant woman requires more food than a normal adult in order to stay healthy. Similarly, in the emissions case, Starkey considers living in a very cold climate; this may require creating more heat to live at a comfortable temperature, which then often requires energy[90]. This can in turn imply higher emissions if, for example, fossil-fuels provide the energy. One might here think that trying to equalise the goal – the 'Y', rather than the resources, 'X', is the only fair solution, implying an unequal distribution of resources, X.

ii) Differences in Y: 'expensive tastes' and 'cheap tastes'

However, people also have different goals, and different goals require different resources (e.g. A enjoys writing, B enjoys fast cars). If it is believed that Y should be equalised and Y differs from person to person, how can it be decided what an equal distribution of Y is? B's tastes – and fulfilment of Y - might require more resources than A's; should, therefore, our principle of equality allow for B's tastes to be equally fulfilled? Depending on the answer to this question we will be led to very different positions.

It might lead to a return to the position of equalising resources in order to rule out fulfilling some very 'expensive' preferences; people's tastes should adapt to equal resource use, and not the other way around (particularly, perhaps, if they have a preference for high-emitting activities). But equally this means that some needs may not be met, if they cannot adapt to equal resource use. So, it might lead to an attempt to accept expensive tastes and the proposal of a further variable, Z, representing welfare. This would amend the earlier formulation to "A uses X to do Y which fulfils Z". Z could be understood subjectively, as, e.g. happiness – so that each person's goals or preferences should be fulfilled to an 'equal' level of Z, and resources distributed to achieve this. However, interpersonal comparisons will be hard, the understanding of welfare may be thought to be too thin, and there is still what Page calls the "cheap tastes" problem; that even then, some needs may not be met, if people are extremely cheerful despite disadvantaged material circumstance[91].

is down to individual choice alone (as opposed to unchosen circumstances, such as family background or physical disability).

[90] Although this need *not* be the case – heat can also be retained by increased insulation, as I suggest in 3.3. See also footnote 96.

[91] Page, 2006, p57, cites Dworkin's example of Tiny Tim, who has insufficient resources for a wheelchair but whose cheerful disposition means that equality of subjective welfare would not require allocating additional

Alternatively, some cheap or expensive tastes could be ruled out by instead allowing Z to be understood 'objectively'; by defining objective criteria of welfare to be met to an equal level, e.g. keeping warm, mental health, etc. Although one will have to address concerns that it will be hard, especially in an international context, to agree on a common welfare standard.

3.3 Equal allowances in theory and practice.

I will not yet argue for any one of these positions, though I consider them more closely in section 4. What should be noted for the moment is that the discussion so far supports Starkey's assertion that equal allowances cannot be justified through an equality of welfare position. For, if the concerns of 3.2. i) and ii) are resolved by taking a position such as equality of (subjective or objective) welfare, this is not guaranteed by equalising the resource in question; emission-generating activity. However, it is also clearly reasonable to adopt an 'equality of resources' position in response to the problem of 'expensive preferences', which is the approach taken by Ronald Dworkin[92]. Perhaps, it might be thought contra Starkey, this kind of approach could be taken to justify a principle of 'equal allowances'.

However, Dworkin does not advocate a strict equality of resources position. For he still has to deal with the issues of the debate summarised in 3.2 i), surrounding differences in the background conditions of individuals. In order to do this Dworkin understands the idea of equality of resources differently. Without dwelling on the details of his argument, the crucial difference is that he supposes a "hypothetical insurance market"[93] against finding oneself in any such disadvantaged position (e.g. being disabled, less talented, etc). Even if nominally it is resources that should be equal for Dworkin, extra allowances are allocated to people that are particularly disadvantaged. Furthermore, Dworkin's theory is meant to apply to all distributable resources, rather than any one in particular (here, emissions space). If, as is the case, other resources are distributed very unequally and are not up for grabs (this is an agreement specifically on climate change mitigation), it does not seem reasonable to straightforwardly draw the conclusion that this one resource be distributed

resources to provide him with one.
[92] Dworkin, 1981b
[93] Dworkin, 1981b, p297-304

equally, since its use *as* a resource may be impacted by inequalities in those other resources.

Because, whilst *some* equality in resources might seem preferable to *no* resource equality, unequal possession of other resources may mean that each party does not even have equal use of that one resource. For example, if parties have vastly unequal access to water, an equal distribution of rice may not allow parties to equally *use* the rice, since some will have insufficient water in which to cook their allocated portion. This is not to suggest that those with less water should be allocated fewer portions of rice; rather, an equal resources view would surely require either that they also be given equal access to water in addition, or above-average portions of rice which can be exchanged with other parties' excess water. Dworkin's 'equality of resources' is therefore no more able to justify a principle of equal emissions allowances (alone) than any variant of equality of welfare.

However, one remaining concern may be that the examples given so far surrounding the variable relationship between resources and welfare need not be applicable, in the case of global emissions space. For the discussion centres on international policy, not national policy. It may therefore be argued necessary only to consider average per capita emissions in a country, since individual abilities or disabilities within a country are likely to cancel one another out (and hence can be accounted for by the national policies of the country). The only differences that are of concern for international policy, this would suggest, are those affecting the ability of a country as a whole to achieve a particular level of welfare from its emissions allowances, such as Starkey's example of living in a colder climate[94]. But even this need not necessarily require the additional emissions that Starkey considers[95] in order to maintain welfare (however one interprets it) – lifestyles and cultural practices can and do adapt so that, for example, dwellings are built with more insulation, clothing is warmer, more exercise is taken. Indeed, perhaps countries should be expected to adapt, as far as possible, to a level of equal emissions allowances[96]. In practice, then, perhaps 'equal allowances' may be perfectly justifiable as a principle of equity to guide emissions

[94] Starkey, 2008, p34
[95] Starkey, 2008, p57
[96] We also, arguably, would not want to *encourage* populations in areas that would require substantially higher energy use to sustain. Dubai, for example, lies within the desert, and in order to sustain its significant urban population has substantial energy use and carbon emissions, a substantial portion of which come from air conditioning (Groom and Leake, 2008).

distribution, even if the ultimate goal of equity is equality of (subjective or objective) welfare.

Yet even if this is allowed for[97], there is one significant 'background condition[98]; the different levels of economic development between countries which results in great differences in the welfare that can be attained from any given level of emissions allowance. It is important, surely, to take on board such differences in the capacity of a country to function from its emissions allowance, and (analogous to the rice example above), equal per capita allowances may not alone be sufficient to imply their equal use *as* resource[99].

4. Capacity

I will now, therefore, turn to what I believe to be the most justifiable principle of equity for a climate change agreement; what is ordinarily referred to as the "capacity" of a country to make limit or reduce emissions. This principle could be understood and defended in different ways, depending on the position adopted on the appropriate equalisandum. Yet not all are equally robust. I will argue in favour of an equality of objective welfare position by sketching a variant of the "capabilities" interpretation of objective welfare. This kind of approach, I will argue, is the appropriate way to justify "capacity" as a principle of equity. It can most fully make sense of the concerns of the proponents of "capacity" as a principle of equity for a mitigation agreement, and allow us to understand why it improves on a principle of equal allowances.

[97] And it is not clear that this *will* be the case – a transition to this would take time. And there may be limits to such adaptation imposed by people's abilities, knowledge, ability to move to more inhabitable areas, and so on. Starkey offers a list of conditions under which an egalitarian liberal might choose equal per capita emissions which includes when adaptation to an equal allocation is possible. (Starkey, 2008, p42).
[98] Although Starkey does consider this in the last section of Starkey, 2008, but restricts himself to a framework of liberal cosmopolitan global justice, drawing on Rawls.
[99] In arguing this I reach a very different conclusion to Page. Although Page does not consider this in significant depth, he does suggest at the very end of Page, 2006, (p178) that the policy proposal Contraction and Convergence, which proposes global equal per capita emissions allowances, "seems well suited to the promotion of existing and future welfare, resources, basic capabilities and midfare", i.e. "any of the plausible theories of the currency of justice".

4.1 Definition of principle of 'Capacity'.

It should first be clarified that there are two subtly different ways of characterising 'Capacity' as a principle. It could be described from primarily a 'burden-sharing' perspective that I considered in section 2.2, where it emphasises a country's ability to pay for reductions from the current distribution of emissions, but ignores the resource-sharing context. This would make the principle problematically approximate to that of 'equal effort', where, as Baer has previously argued, it is a variant of a "principle of equal sacrifice" for reduction burdens, when "the wealthy pay a higher proportion of their income than the poor do, but the poor still pay something"[100]. Singer has also described the principle in a similar way, when he stated that "it is fair for the better-off to make greater sacrifices than the worst-off"[101]. I have already explained my concerns with the limitations of this kind of perspective (which could result, potentially, in the wealthiest making a greater "sacrifice" in *reductions* than the poorest, but with the poorest still receiving lower emissions allowances).

Instead, therefore, I adopt an understanding of 'Capacity' that also recognises the resource-sharing perspective. This emphasises the "capacity to act"[102] of each country. But "capacity" refers not simply to the "opportunity to reduce emissions" in the sense of efficiency highlighted in 1.3. but in terms of the capacity of a country to adapt to functioning from a given emissions level. Page has questioned the "ability to pay" principle on the grounds that "it leaves unanswered *why* those who have the ability *should* pay"[103]. My concern in this section is to consider an ethical grounding for this principle under different interpretations of a country's capacity according to the 'equality of what' literature introduced in section 3.

Why then, at a political level, would capacity be argued to be an appropriate principle of equity for a mitigation agreement? The main argument (which I have framed within a

[100] Baer, 2002, p395. As mentioned earlier, he has, however, subsequently promoted a burden-sharing approach in the Greenhouse Development Rights Framework (Baer et al, 2008), although, this framework still retains the important context of equitably sharing emissions space.
[101] Singer, 2006, p419.
[102] Ashton and Wang, 2003, p4
[103] Page, 2008, p562. He is concerned about why countries that have not necessarily been responsible in the past for excessive greenhouse gas emissions but are still comparatively rich should nonetheless "pay" a greater amount than poorer countries who have.

resource-sharing perspective) runs as follows[104]: because countries are unequally economically developed, and development has so far depended on greenhouse gas emitting activities, simply allocating equal emissions to each country (when the level of the emissions budget must now be set so extremely low) could "lock-in"[105] this inequality. The "legitimate economic aspirations" of developing countries may be threatened; not because development always requires high levels of emissions, but because of the scale and speed of the reductions that are now needed[106]. The faster that poorer countries have to "decarbonize their economies"[107], the more difficult it will be to do this whilst *improving* standards of living to alleviate poverty. For the latter typically requires "a vast expansion of energy services" to provide e.g. "clean cooking fuels to escape the epidemic of severe respiratory illness in poor households... electricity... to treat and pump fresh drinking water"[108], and will make the process of decarbonisation even more challenging[109].

Crucially, for Baer et al, "the equal sharing of almost-exhausted resources is not equitable" and a global agreement should ensure that those already wealthy countries contribute sufficiently to global mitigation efforts so that "global emergency mobilization [i.e. in reducing emissions] can proceed without stifling development in the South"[110]. Countries that can "pay" *should* pay, then, if we care about the prospects for reducing global inequality or alleviating poverty once emissions limits are in place. The Capacity principle could accordingly distribute emissions unequally, so that less developed countries could receive higher than average emissions allowances[111] to allow them to develop[112] whilst they

[104] Adapted from the Greenhouse Development Rights Framework, Baer et al, 2008
[105] Baer et al, 2008, p27.
[106] Baer et al highlight that even if all remaining emissions space were ceded to non-industrialised countries, "the dramatic emission reductions demanded by the climate crisis would still require the developing countries to urgently decarbonize their economies."
[107] Baer et al, 2008, p27.
[108] Baer et al, 2008, p37
[109] Baer et al, 2008, p27. Additionally, what Baer et al do not mention here, but which is more widely acknowledged is that poorer countries will also have to deal with disproportionately harmful impacts of DACC, which, as I have argued in chapter 2 section 4, we are already experiencing and some further levels of which are unfortunately now inevitable. Whilst I do not deal directly with adaptation issues in this thesis, this is nonetheless an additional pressure on the Capacity of poorer countries.
[110] Baer et al, 2008, p27
[111] Recalling that these would still be massively lower than the "business-as-usual" emissions of poorer countries without a cap – see footnote 106.
[112] The idea of "development" has been subject to much criticism in so far as it often substitutes for unrestrained economic growth. However, Baer et al are clear that 'development' should be understood not be understood this way, but as "the satisfaction of fundamental needs in a manner that frees people from vulnerability and deprivation of poverty and makes possible a decent level of security and well-being." (Baer et al, 2008, p39)

make the transition; wealthier countries, given their greater capacity would have lower than average allowances.

There are some concerns with this argument as it stands. Firstly, one might contest whether richer countries would in fact have a greater capacity than the the poorest countries to reduce to absolutely lower levels of emissions. Given the scale and speed of the reductions needed, other challenges would be presented by having to dismantle and realign a large *existing* infrastructure designed around fossil-fuel use; in effect, it would require industrial countries to achieve a a zero carbon transition in a much shorter timescale, and there may be limits to how quickly this could be achieved[113] . Whilst this constraint must be recognised, equally, some middle-income countries such as China have significant high-emitting industrial infrastructure; this challenge would therefore not be restricted to the wealthiest countries. Secondly, the development of poorer countries that Baer et al point to as requiring "a vast expansion of energy services" could, in theory, proceed with low or zero emission technologies[114]. The barrier to this may be, rather, that developing these alternatives requires additional resources, technology or financial support, rather than higher emissions permits (than under EPCAs – as suggested, it would still require a significant reduction from "Business-As-Usual" emissions).

But how far either concern holds is an empirical question: they give no reason to assume that a Capacity principle would in either case coincide with equal allowances alone. I therefore suggest understanding the Capacity principle as advocating *either* unequal distribution of emissions (in so far as this is necessary to prevent 'lock-in' of global inequality) *or* supplementing equal allocations by payments from rich to poor nations as well as other resource and technology transfers, to enable the latter to switch to develop low carbon infrastructure. In fact, the latter is broadly implied by Baer et al, since they envisage the trading of allowances[115]; this means that, in effect, richer countries would fund some emissions reductions in poorer countries in addition to steep domestic cuts[116].

[113] See chapter 2, section 2.4 regarding how the 'possibility' of this occurring should be understood.
[114] For example, non-electric water pumps.
[115] Not least because Baer et al's calculations of emissions allocations which take account of both capacity and responsibility give some richer countries *negative* emissions, which (barring geo-engineering alluded to in chapter 2 section 4 as problematic) would be impossible to achieve.
[116] Indeed, they make clear that this "exists by design", Baer et al, 2008, p71

What is yet unclear is the view of equality is being held from an ethical perspective. I therefore now consider each of the main positions on equality[117] and explain the problems I believe they encounter. Prima facie, each could be held to justify the principle of Capacity in a way that they could not justify 'Equal Allowances'. However, not all adequately capture the moral instincts behind the principle.

4.2 Resources view of Capacity.

A resources view of equality might be thought to underlie a principle of Capacity by taking total resources - rather than simply 'emissions space' – to be the relevant equalisandum. Capacity would then be understood as total wealth, or income (per capita), and the differences between industrialised and developing countries seen as differences in the quantity of resources possessed. Distributing emissions allowances according to capacity might then be a way to move towards equality of total resources (say, by making allowances inversely proportional to wealth), and to take account of possessions by some countries of resources other than "emissions space" in distributing the latter. However, this does not accurately reflect the force of the capacity argument expressed earlier. It does not provide a clear idea of *how* to take account of existing resources – given that one cannot in any case achieve equality of total resources in an agreement specifically about climate change mitigation.

Rather, as considered in section 3.3 through the rice-water scenario, the relevance of inequalities in other resources seem primarily to be that they do not enable emissions allowances themselves to be used equally as a resource. But in this case, the moral thrust of the argument is then directed towards the function of emissions allowances; what they are used *for* – i.e. for development and increasing standards of living. This reflects the problem of value that was considered in 3.1, that, as economist Amartya Sen has similarly suggested, "The usefulness of wealth lies in the things that it allows us to do"[118]. Whereas, to adopt a 'resources' perspective locates the value of a resource in its possession, rather than the ends it is used *for*. There remains the problem (section 3.2, i.) of the gap between

[117] I.e. positions on the 'equality of what' debate.
[118] Sen, 1999, p14

possession of resources and their useful ends, a relationship that can vary depending on ability, knowledge, social practice, and environmental circumstance, for example.[119]

These concerns imply a welfare-based position; that capacity should be understood not simply in terms of wealth or income possessed, but the welfare level or standard of living that is and can be attained.

4.3 Subjective Welfare view of Capacity.

It might seem reasonable instead to adopt some version of the 'subjective welfare' view, and judge a country's 'capacity' to adjust to a particular emissions level in terms of the level of subjective welfare that would be achieved by its inhabitants. Variations of a 'subjective welfare' approach try to take account of the different preferences that people hold, and their varying 'utility functions' – that different goods, or different amounts of goods will be experienced differently. This then understands well-being in terms of utility, pleasure or happiness, and the relevant 'equalisandum' according to which resources should be distributed. However, it is hard to see how, especially in an international context, one could relate happiness to emissions use in a useful way. Even setting aside the problems surrounding interpersonal comparisons of subjective welfare, it does not seem promising to try to establish a relationship between emissions use and an overall subjective state of mind that depends on so many other factors.

Firstly, the relationship could clearly not be a direct one. That is, it cannot be assumed that increases in emissions use also increase happiness, and that less wealthy countries should be given extra emissions because they are less happy. For a little reflection reveals this is not the case in any straightforward way; it is not the emissions use itself that increases happiness. One can imagine many activities that could require emissions use that will make people less happy, for example, an high emitting coal-powered torture chamber, not to mention very real scenarios such as DACC. Rather, if there were to be a link between emissions use and, say, happiness, it would depend on the activity concerned, the way that the emissions allowance is used and individual perceptions.

[119] Baer et al, 2008 make this kind of point; "Capacity reflects wealth...the portion of national wealth that can reasonably be tapped to respond to the climate crisis. *But all wealth is not equal*. Its definition must be reconciled with the right to development" (p45, my emphasis).

At the same time, there is some sort of correlation between emissions use and happiness. If there was no desire for the (short term) 'benefits' brought by fossil fuel use which clearly exist – quick, cheap, easy energy that allows goods and people to travel vast distances very quickly, replace manual tasks with automatic processes, etc. – then we would not be in the dire situation that we now face. However, research on world 'happiness' indices have looked at the relationship between overall 'happiness' and per capita GDP and consumption levels[120] (the latter two, as mentioned in chapter 1, are currently tied to emissions levels[121]). These kinds of studies suggest that, in fact, happiness depends on various cultural expectations and, above a certain minimum level, does not always increase as income rises. There are a multitude of ways that people can be happy irrespective of resources used, and it seems reasonable to assume that this will be true of high or low emissions use. In fact, there are reasons to believe that (beyond a certain minimum, at least) higher emissions use will in general make people less happy, because of, for example, DACC, air quality, the impact of readily available energy on transport use that replaces healthy activities like walking and cycling, and so on.

So it does not seem correct to suppose even a general indirect relationship between emissions use and happiness, even if many people currently have a preference for high-emitting activities. But it might appear unnecessary in any case to establish a fixed relationship between happiness and emissions use in the first place. The Capacity principle, understood according to an equality of subjective welfare position would instead seek to distribute emissions in so far as they do in fact contribute towards an equal level of happiness. However, there is something worrying about this way of characterising welfare. For locating the value of emissions distribution in entirely subjective characteristics such as happiness or preference satisfaction will depend on existing mental states. And, if we acknowledge the existence of endogenous rather than fixed preferences, our happiness and personal preferences are based, in part at least, on what one is used to, on "mental conditioning"[122], to borrow a phrase from Sen. In particular, regarding the case of emissions distribution, it could well be used to justify the 'grandfathering' of emissions – i.e. distribution of emissions in proportion to their current distribution between countries,

[120] For example, the New Economic Foundation's "Happy Planet Index" and the World Values survey, summarised in BBC articles (2006) and (2003) respectively.
[121] See Meyer, 2000, p28, cited in chapter 1, section 3.2
[122] Sen, 1999, p62

since, for example, inhabitants of richer countries are used to a more emissions-expensive lifestyle than poorer countries, and their tastes and preference expectations will reflect this.

This emphasises the very real problems of the classic "expensive tastes" argument in the equality literature. These should not be ignored since, as Sen has argued in a development context, it seems "deeply unfair to those who are persistently deprived"[123], and would justify largely maintaining the status quo, no matter how deep the inequalities. There also appears to be a circularity in this welfare approach that undermines the normative task. That is, an appropriate understanding of an equitable distribution is being sought, but if this is done in terms of preference satisfaction or other entirely subjective criteria, these are based themselves on the existing distribution. It seems reasonable to require that, just as tastes should be altered to reflect other moral criteria (i.e. we do not pander to people with a penchant for torture), tastes and lifestyles should be expected to adapt to lower level of resource use. This means that some kind of prior, normative conception of welfare is required in order to assess a country's "Capacity" for emissions limits.

4.4 Objective welfare view of Capacity

I now consider how it might be possible to understand the principle of "Capacity" as grounded in an approach to equality that sees objective welfare as the moral bearer of value. If it is determined what kinds of welfare are valuable to possess, then emissions could be distributed on the basis of the welfare they will contribute to, and the kinds of welfare felt to be right that people hold equally. The most obvious counter is typified by Arneson's objection that "perfectionist"[124] approaches assume that the same goals in life will apply for all. This can be the case with standard 'needs' based approaches to objective welfare which understand needs too directly in terms of particular resources. I will turn to these possible limitations with a 'needs' approach in section 5.1, although I also consider there a possible conception of 'needs' that is similar to the 'capabilities' approach discussed below. This could form a plausible alternative conception of objective welfare for understanding capacity, but I focus here on 'capabilities' because it is unclear how far this understanding of 'need' would offer an improvement on the 'capabilities' view.

[123] Ibid.
[124] Arneson, 1990, p197

I turn now to an approach that I see as offering roughly the kind of framework required for objective welfare; the 'capabilities' approach, first put forward by Amartya Sen[125]. The version that I outline here is my understanding of Sen's position, although other readings may differ and there are further variations on 'Capabilities' (such as the work of Martha Nussbaum[126]). I think this promising, but not without difficulties. I suggest towards the end of this section how I think Sen's approach would need to be altered to constitute a more appropriate conception of objective welfare from a Green Economic perspective and for international climate policy.

Sen's approach understands welfare not in terms of mental states or resources, but in terms of the ability to do or be certain things. Capabilities are:

> "alternative combinations of functionings that are feasible for [a person] to achieve"

And the 'functionings' we are able to 'achieve' are not passive states, but;

> "the various things a person may value doing or being"[127]

Examples might be 'being free from disease' or 'taking part in community life'[128]. In other words, capabilities are freedoms to function in different ways that are valuable to human flourishing. It is, Sen claims, a "freedom centred perspective" similar to "the common concern with quality of life"[129]

Caution is needed, I suggest, about how this is understood as an approach to equality, and an 'answer' to the 'equality of what?' question. Firstly, capabilities will depend in part on resource use (although they are by no means exhausted by it). They include the resources that people may have at their disposal, since "income… has an enormous influence on what we can or cannot do"[130] Capabilities should not, then, be seen as simply the 'space' between resources and welfare.

[125] See Sen, 1999
[126] See Nussbaum, 2000
[127] Sen, 1999, p74-5
[128] Sen, 1999, p75.
[129] Ibid.
[130] Sen, 1999, p72.

Secondly, it is not enough to simply consider 'capabilities' as the equalisandum itself, as though they can be combined into a distinct, single magnitude that could be equalised. As Sen points out, there are multiple capabilities we might think of as constitutive of a good quality of life, which cannot be combined into one 'magnitude' such as utility. "The capability perspective is inescapably pluralist", he says – in that there is a "Heterogeneity of factors that influence individual advantage"[131]. Inequalities in standard of living can be judged differently depending on which functionings are being considered. And some functionings may be considered more important than others, and it will be a question of evaluation and debate as to which functionings are more important. This requires what I would call an objective conception of welfare, although the *process* for developing the conception need not be seen as rigid, as equivalent to the a 'discovery' of a 'hidden' truth. It is, for Sen, an irreducibly judgemental exercise requiring continual reasoned social evaluation.

There is, clearly, a dilemma as to the level of specifity of capabilities in an international, multi-cultural context. Too concrete, and they will arguably be too culture-specific; too general and open to interpretation and they will fail to be useful in offering a conception of welfare that can guide international policy and, in particular, resource distribution. Although some cultural diversity must surely be allowed for, if we lean too far towards a more general framing of capabilities it will fail to be sufficiently normative because it risks collapsing back into a form of subjective welfare. For example, if one advocates an equal capability to nourish oneself, societies that view meat-eating as essential to nourishment will require far higher emissions allocations than those that are predominantly vegetarian. I would therefore not advocate interpretations of 'capabilities' that see them as entirely morally 'neutral' between conceptions of the good, in the Rawlsian, liberal sense[132]. For we must surely, particularly with in the case of DACC and recognition of the limits to (at least, emissions) growth, revise our ideas of a morally acceptable lifestyle in terms of treading more lightly on the earth. There will be some (ecologically risky) practices that should not be allowed for.[133]

[131] Sen, 1999, p76

[132] It is not clear to me what position Sen takes on this, though this is the interpretation I would *hope* to be correct, if 'capabilities' are not just to face the same problems of subjective welfare.

[133] This is analogous to the idea that, as I suggested in 4.3, morally acceptable lifestyles already exclude those that, for example, cause other kinds of harm, such as torture. The issue, of course, in our emissions case is that it is not clear in advance of further discussion *how* expensive these practices would need to be to be

This will therefore require an appropriate balance between the two concerns, through a process of research, negotiation and international debate, as has had to occur with formulating, for example, the Millennium Development Goals, and the Universal Declaration of Human Rights. This kind of difficulty does not present itself in the same way to Sen, since he understands capabilities within the context of a particular society, for that society to determine through "public discussion and a democratic understanding and acceptance"[134]. Nussbaum's approach may seem preferable in this sense, since she outlines ten "central functional human capabilities"[135], which are specifically conceived as cross-cultural[136]. However, the specific capabilities would need further consideration and development with regards to whether they are adequate to express those capabilities which may be threatened by an inadequate zero-carbon transition. Her approach is also problematic in so far as it is broadly 'sufficientarian' and ambivalent about inequalities beyond these basic capabilities, as considered below.

Further ethical, philosophical consideration would be required to consider how this 'balance' can be achieved. There is not space to develop such content here, but it is worth highlighting another very important way in which the capabilities approach would need to be amended. This is that, as framed by Sen at least, there seem to be unlimited capabilities which could potentially be met, in the sense of freedoms to do or be certain things. However, a green approach to well-being would also need to embrace the concept of 'enough'; that, in contrast to the conventional economic understanding of "homo economicus" highlighted by Daly and Cobb[137] and outlined in Chapter 1, humans should not be conceived as having unlimited wants and desires, but capable of satiety and fulfillment. This is partly important within the context of ecological limits, and the impossibility of unlimited material growth considered in chapter 1, section 3.1, because "once we recognise the imperative of sustainability we must draw conclusions about morally acceptable levels of consumption"[138].

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deemed morally unacceptable because this is itself partly determined by the idea of an equitable share. But this grey area merely highlights the need for that discussion to take place; the point still holds that in general, minimising ecological impact should be considered as a relevant moral limitation on lifestyle. And practices will be less grey the more emissions expensive they are and the less important the capability.

[134] Sen, 1999, p79
[135] Nussbaum, 2001, p54
[136] Nussbaum, 2001, p53
[137] Daly & Cobb, 1990, p85
[138] Scott-Cato, 1999, p44

Accordingly, Meadows et al, suggest, the world should adopt a "definition of enough"[139], where people "establish their status, derive satisfaction, and challenge themselves with goals other than ever-increasing production and ever-accumulating material wealth"[140]. But the concept of "enough" is also recognised as important by green thinkers because, as alluded to earlier[141], research has suggested that "beyond a certain level of growth, human well-being clearly declines"[142]. There is, therefore, a distinction between "frugality" and "poverty"[143]. Rawls also recognised this, arguing that only a certain degree of accumulation is necessary for "the full realization of just institutions and the fair value of liberty", that "It is a mistake to believe that a just and good society must wait upon a high material standard of life... great wealth is not required. In fact, beyond some point it is more likely to be a positive hindrance, a meaningless distraction at best if not a temptation to indulgence and emptiness"[144]. The level that is required is what Read has called "rich subsistence".[145]

However, my position here is different to the "sufficientarian" position. Sufficientarianism, as Page highlights, requires that "as many people as possible should have enough to pursue the aims and aspirations they affirm"[146]. It has in common with my position that "Having enough.. is not the same as living a bearable life... Rather it involves a person leading a life that contains no substantial distress or dissatisfaction." However, briefly, it differs in two ways. Firstly, it is sufficiency rather than equality that is important, so that "If everyone had enough it would be of no moral consequence whether some had more than others."[147]. Whereas I am suggesting that wealth beyond this point is not only unnecessary but ecologically, socially and psychologically detrimental. In section 5.2. I also consider why relative deprivation is itself harmful to well-being[148]. Secondly, neither are sufficientarians

[139] Meadows et al, 2005, p11 & chapter 7, especially p238-240
[140] Meadows et al, 2005, p240
[141] Section 4.3 (research relating GDP to happiness).
[142] Scott-Cato, 1999, p42
[143] Scott-Cato, 1999, p44
[144] Rawls, 1972, p290. However, Rawls does not integrate this insight into the main body of his theory of justice, which fails to recognise the implications of limits to growth, as Read, 2011, has argued.
[145] Dr Rupert Read (personal conversation).
[146] Page, 2006, p85
[147] This is similarly true of Nussbaum's alternative understanding of "basic capabilities", which, as it stands, is broadly sufficientarian in that, as Page suggests, "Inequalities above the point where all have enough of all capabilities are not dealt with" (Page, 2006, p69).
[148] Although oddly, Page considers the literature on the harmfulness of relative inequality to imply not that relative inequality should be avoided, but that one should be suspicious of equality itself because of psychological harms associated with the "*preoccupation* with comparative economic wealth and status".

concerned with inequality *below* the level of sufficiency; the concern, as Page emphasises, is that "as many people as possible" should have enough. Whereas I have been considering a position of "equality of objective welfare" up to the point of sufficiency.

4.5 Application to 'Capacity' as principle of equity.

I now outline how the 'capabilities' approach could be generally applied to the current context as a way to understand the 'Capacity' principle. It would, then, judge the 'capacity' of a country to make emissions reductions in terms of the comparable effects of an emissions allowance on the standard of living. And 'standard of living' would be understood not simply in terms of resources, but objective welfare; the actual capabilities to function in different valuable ways which are affected by emissions reductions. For example, emissions are a by-product of energy production or energy use for various activities ranging from keeping warm and cooking food to manufacture, transportation, etc; in fact, they are embodied in most activities in industrialised countries, because of the dependence of our economic system on fossil fuel use. So our current 'functionings', from 'being warm' to 'being able to travel far' are dependent on them. Of course, since it is not the resources themselves that matter, but the capabilities achievable that constitute human flourishing, if these can be achieved in different ways, that do not rely so heavily on emissions activities, then lowering emissions need not also lower achievable functionings. And this is indeed the case. Energy can be gained from lower or zero-emissions sources such as renewables and through changes to activities to lower the amount of energy spent on them, through improved efficiency, lowering distance travelled, and similar measures.

The question for the Capacity principle, and what seems to be at the heart of Baer et al's concern with "developmental equity"[149], is what will be the effect on standard of living – on people's capabilities - if the country they inhabit has to lower emissions to any particular level in a given time period? And how would a similar level of emissions in a poorer country affect its standard of living? In general terms, those living in an industrialised country can afford to make many quicker, deeper changes to their economic

(Page, 2006, p87, my emphasis). Whilst the preoccupation may be harmful, surely what is problematic here is not the idea of equality but the fetishism of wealth and accumulation set up as an aspiration. This precisely depends on *inequality*, since one can only acquire economic status *relative* to the lesser wealth of others; it is 'positional', as Hirsch argues (Hirsch, 1976, p52).

[149] Baer & Athanisiou, 2007b, p31

activities to lower emissions over time to extremely low levels and affect the functionings available to them – their capabilities – in more minor ways, compared to poorer countries. The kinds of things it would mean are, for example, importing far less food from abroad, travelling less, consuming less, and associated economic changes to job patterns, shifts in industry, business and agriculture[150]. Whilst this would certainly restrict people's capability sets, it would not necessarily impact on more fundamental functionings, such as ability to stay healthy, achieve bodily comfort, and so on, because of the ability to invest in low emissions technology and initiate other socio-economic changes to support these functionings through other means.

But for poorer countries who currently have a far lower standard of living, they would face the double task of making the investment to shift to non-emitting economic activities but also *improving* their standard of living - developing their 'capability set" to lift themselves out of poverty. To make the change to alternative energy sources and alternative means of improving standards of living requires an initial energy investment. To sustain and improve levels of capability (i.e. to continue to develop) *and* make this transition so that these capabilities operate in non-emitting ways, poorer countries may require an initially higher allocation of emissions than under equal-per-capita allowances[151], or other kinds of support – finance, technology, knowledge-transfer. Under a global equal per capita allowance alone, given the size of reductions now needed, poorer countries may not have the capacity to do both, placing far more basic capabilities under threat.

Assessing policies on emissions distribution according to "Capacity" on a capabilities view, would, to summarise, mean considering how far the distribution of emissions allowances enables a country's inhabitants to attain certain relevant functionings on that allowance. This could either be accommodated by giving higher emissions allocations to countries with lower capacity, or through their equal allocations being supplemented with transfer of other forms of support and resources[152] that would allow the transition to take place and allow for the development of equal capabilities (/standard of living) through low-emitting means. As suggested in 4.1, how far either is the case is a broadly empirical question, requiring knowledge of the political, economic and social organisation and the industrial infrastructure of different countries.

[150] See e.g. the Zero-Carbon Britain report (Helweg-Larsen & Bull, 2007)
[151] Baer et al, 2008, p27
[152] Although I argue against one potential mechanism for this, carbon trading, in chapter 4.

However, I do not suggest that such a principle should be implemented directly and literally in an international mitigation agreement with a view to exactly equalising between countries all capabilities affected by emitting activity. This would be prohibitively complex, and, given that capabilities and standard of living more broadly depend on many other factors and take time to be developed, suggests that such an attempt would not be meaningful, even in theory. Rather, policies should be assessed and developed with Capacity (and the value of objective well-being) in mind as the aim guiding equity; for any distribution of emissions entitlements between countries, it should be borne in mind what impacts it could have on the prospects for equal objective well-being/capabilities, now and in the future, based on an understanding of the scale of the transition challenge in different areas of the world. Here a balance must be struck between ethics and pragmatism / simplicity[153] in working out how far these concerns should affect emissions entitlements.

I have tried here to cover the main reasons why I believe that the capabilities approach offers a promising "objective welfare" understanding of the principle of Capacity as an equitable principle for emissions distribution. However, as mentioned earlier, capabilities are not the only possible interpretation of an objective welfare position which I have argued we need to adopt. A further position is offered through the concept of 'needs', which is also directly appealed to in the (related) fourth possible principle of equity, 'Basic Needs'. It is to this principle I shall now turn. I suggest in section 5 that 'needs' may offer a reasonable alternative version of objective welfare to 'capabilities' (i.e. an alternative equalisandum), although it is unclear how distinct this would be from the approach to capabilities which I have suggested. However, I also explain my concerns with the prioritarian formulation of the '*Basic* Needs' conception of equity which is distinct from the egalitarian basis for the Capacity principle.

5. Basic Needs

Distribution according to 'Basic needs' could be considered an equally reasonable contender for a justifiable principle of equity for emissions distribution as Capacity. For, it

[153] This, arguably, is of procedural importance in ensuring the transparency and accountabiliy of policy, to ensure it is less susceptible to corruption. However, I do not focus on procedural issues here.

considers equity within a resource-sharing framework (unlike 'comparable effort'), and it offers a moral grounding for the distribution of emissions space (unlike 'equal allowances').

In particular, 'basic needs' could be seen as a similar kind of principle to the principle of Capacity in that it also distributes resources, broadly speaking, on the basis of standard of living, but with two differences:

i) It is more clearly positioned in the 'equality of what' debate as an objective welfare conception(whereas 'Capacity' is ambiguous), defining 'needs' as the relevant 'equalisandum', except that….
ii) It takes a prioritarian approach to i), in that it considers distribution of resources only in so far as the distribution allows some specified 'basic' levels of need to be met, rather than seeking equality as such above this level[154].

Ignoring for the moment the prioritarian aspect (i.e. the "basic" of "Basic Needs"), I first consider i) – whether 'needs' offer an alternative, perhaps more obvious, conception of objective welfare to the 'capabilities' approach that I argued for in the previous section. It is important to emphasise that since this initial discussion is about the appropriate conception of objective welfare/the equalisandum, it is relevant both to Capacity and to Basic Needs, since I have argued in section 4 that Capacity should also be grounded in an equality of objective welfare position. I want to suggest why the 'needs' conception may hold some merit, as an alternative to "capabilities".

5.1 "Needs" as an alternative version of objective welfare

The terminology of 'need' might seem a more familiar, far simpler way of describing standard of living. It would mean that emissions distribution would depend[155] on the needs of the country that they will meet. The problem is that the standard interpretation of 'need' is in terms of resources[156]. To return briefly to the simple formula expressing the

[154] For full definition and discussion of prioritarianism, see 5.2
[155] "Depend", that is, either through a prioritarian (Basic Needs) approach or an egalitarian (Capacity) approach since it could apply to either.
[156] See, e.g. "Basic Needs" entry (Paul Spicker) in Encyclopedia of International Development, Forsyth, 2005; "A "basic needs" approach to development focuses on providing access to the minimum income or items necessary to ensure the continuation of healthy life".

relationship of resources and welfare, "A needs X in order to Y", needs are ordinarily defined as the "X" in question, e.g. water and food. But this implies a stronger, necessary relationship between X and Y. The problem in the mitigation case is that it does not make sense to say this when the resource in question is emissions, since this would not make sense of moves away from emissions use.

As an example of the kind of ambiguity in meaning, I turn to Henry Shue, who argues in a similar vein to my arguments surrounding 'Capacity', that when distributing emissions allowances, we should consider what they are used *for*. He distinguishes between "luxury" and "survival" emissions; that proportion of emissions use that is used for 'luxury' activities, compared to those used for basic survival, such as agriculture; "some sources [of emissions] are essential and even urgent for the fulfillment of vital needs and other sources are inessential or even frivolous"[157]. Shue argues that developed countries should have to sacrifice their luxury emissions before developing countries should sacrifice their survival emissions[158].

In one sense this seems obviously fair[159], and not disimilar to the capabilities approach to Capacity, except seen in terms of two categories of standard of living rather than a continuum. The difference here is that, because of the emphasis on the resource itself, it does not say anything about how we *should* or *could* use emissions. One might therefore conclude that because currently 'survival' related activities are currently dependent on a certain level of emissions, these emissions levels should always be maintained. But it is entirely possible, as has been argued earlier, that these emissions can be lowered whilst maintaining (or raising) this basic standard of living (e.g. through improved efficiency, alternative techniques, energy and so on). It is not that the emissions themselves are necessary for survival – it is that they currently are used for survival activities rather than luxury activities. There is therefore something very unsatisfactory about this conception of 'needs'.

[157] Shue, 1993, p55
[158] Indeed, this is sometimes how the Greenhouse Development Rights argument for Capacity is framed, e.g. Baer et al, 2008, p45.
[159] In as far as it is an argument for considering the use of emissions, against "the principle of least-cost first", Shue, 1993, p55.

However, one could instead interpret ‘needs’ more in line with the capabilities approach – that is, in terms of defining certain ‘functionings’ vital to human flourishing. A more satisfying conception of basic needs along these lines is present, for example, in Doyal and Gough’s model.[160] The ‘needs’ they outline in their theory are not tied to particular resources. Rather, they understand the 'objectivity' of 'basic human needs' through the conception of basic needs as the 'conditions necessary" for the "avoidance of serious harm",[161] but harm conceived of in terms of "dramatically impaired [social] participation in a form of life".[162] Thus they define two ‘basic needs’, ‘physical health’ and ‘autonomy’, which they describe largely in terms of an individual’s capacity. For example, lack of 'physical health' is described in terms of illness that violates one’s “perceived ability to participate” and renders them “functionally incapable of sustained participation in practice”.[163] Similarly, for 'autonomy'; "individuals express their autonomy with reference to their capacity to formulate consistent aims and strategies", autonomy which varies with "understanding", "psychological capacity" ('mental health')[164] and "opportunities" for "socially significant" action[165]. Indeed, they later point out that their "basic needs for physical health and autonomy are closely related to functionings"[166] as understood by Sen.

Although the approach is clearly significantly different from Sen's in certain aspects - such as the description of only two, broadly conceived basic needs, compared to Sen's larger range of valuable functionings - these differences are not tied to the use of a 'needs' versus 'capabilities' metric. Degree of specificity, as discussed in 4.5, will be an issue for conceptions of 'need' and 'capabilities' alike.

And Doyal and Gough draw attention to the theoretical similarities between their theory and Sen's 'capabilities' approach in terms of the role of resources and their cultural variability;

> “While the basic individual needs for physical health and autonomy are universal, many goods and services required to satisfy these needs are

[160] Doyal & Gough, 1991.
[161] Doyal & Gough, p50
[162] Doyal & Gough, p55
[163] Doyal & Gough, p57-8
[164] Doyal & Gough, p60
[165] Doyal & Gough, p66
[166] Doyal & Gough, p156

> culturally variable... [these are] our basic needs 'satisfiers'. Basic needs, then, are always universal but their satisfiers are often relative. Sen has made a similar point in his analysis of poverty: 'Poverty is an absolute notion in the space of capabilities but very often it will take a relative form in the space of commodities or characteristics'... The existence of basic needs or capabilities which are universal to all people is quite consistent in theory with a rich variety of ways in which they can be met and a wide variation in the quantity of satisfiers required to meet them"[167]

So, whilst I do not wish to analyse here the specific content of Doyal and Gough's theory of human need, I see no reason here why an approach of this sort could not potentially be taken in describing objective welfare (and, therefore, be used as a variant of the principle of Capacity). It would need, however, to take account of the kind of criticism made by Sen, that the concept of meeting 'needs' makes people "passive recipients of the fruits of cunning development programs", whereas, "The people have to be seen as being actively involved… in shaping their own destiny", which Sen argues is crucial to the idea of 'capabilities'[168][169]. However, this would require further consideration elsewhere. If 'needs' *were* successfully reinterpreted along these lines, I do not then see that there is much to choose between the two positions of 'needs' and 'capabilities', in so far as we are considering the 'equality of what' question and providing interpretations of objective welfare for a principle of equity for emissions distribution.

5.2 Basic Needs as a prioritarian version of Capacity.

Since, therefore, both Capacity and Basic Needs could reasonably draw their conceptions of objective welfare from either 'capabilities' or 'needs' based approaches, the primary difference remaining between them is the issue outlined in ii) above. That is, that whereas Capacity is an egalitarian principle, the 'basic needs' position is prioritarian. It seeks to distribute emissions allowances so as to prioritise those who have not met a certain basic standard of living rather than seeking to remove relevant inequalities[170] at all levels.

[167] Doyal & Gough, 1991, p155
[168] Sen, 1999, p53.
[169] Promisingly along these lines is Benton's understanding of "needs" as part of a "human welfare ecology", which he frames as being active rather than passive; "satisfying and fulfilling work for convivial working relations and for democratic participation" (Benton, 1999, p227)
[170] I.e. relevant to/dependent on use of emissions space

I allude here to a second major debate in the philosophical literature on equality; what Parfit has dubbed the 'equality or priority' debate[171]. Here, more specifically, a distinction is made between 'strict egalitarians' who require a reduction in *relative* deprivation and 'non-relational egalitarians' – 'prioritarians' who require a reduction in absolute deprivation. For prioritarians, according to Parfit, when (re)distribution is being considered, "benefits to the worse off matter more, but that is only because these people are at a lower *absolute* level"[172]. But strict egalitarians "are concerned with *relativities*: with how each person's level compares with the level of other people".

This debate cuts across the 'equality of what' debate. As noted by Clayton and Williams, the "equality of what" debate is common to both egalitarians and prioritarians[173], in specifying "the conditions under which some individuals are worse off than others". But the difference to policy regarding the 'equality versus priority' issue is that, prioritarianism, does not necessarily imply total equality of ones desired equalisandum, and may just imply less inequality. It will require that some minimum level (of welfare, resources, oppportunity) should be met for everyone as a priority for resource distribution.

However, I think that there are two ways that the prioritarian position might be interpreted from Parfit's description, which will ultimately bear on how the 'basic needs' principle is interpreted. Parfit says that the prioritarian wants to prioritise the well-being of the worst-off, "because these people are at a lower *absolute* level". But what does 'absolute' mean, here? It could mean, it seems to me:

a) Consider the collection of people relevant to your distribution[174]. Decide, *of these* (according to your answer to the 'equality of what' question), who is the worst-off, and whoever this is, they should receive priority in distributing resources[175].

b) Define a list of criteria (according to your answer to the 'equality of what' question) that defines what it means to be badly off, or in poverty (e.g. less than a

[171] Parfit, 1995. As noted earlier, Page calls this the "shape" of justice, Page, 2006, p51
[172] Parfit, 1995. p104
[173] Clayton and Williams, 2002, p8.
[174] I refer to 'collection of people' for the moment so as not to complicate things by trying to account for inequality within countries as well as between countries.
[175] Rawls' 'maximin' principle (extended at a global level by Pogge, 1989) would be a variation on this.

dollar a day, no access to clean water, being unable to be bodily nourished). Whoever, in the collection of people, meets these criteria qualifies as the 'worst-off' group. NB: this group could theoretically be 'empty', in a wealthy society.[176] This latter view has some similarities to but is distinct from a further "sufficientarian position", which I do not consider here, since it straightforwardly rejects equality as important[177].

To explain the difference between these two interpretations (and between these and a strict egalitarian position), one can imagine, for simplicity's sake, that the relevant 'equalisandum' has been decided and that this will be measured in numerical units. Suppose the following two alternative scenarios exist:

Scenario 1:	Group A	Group B
	10 units	2 units
Scenario 2:	Group A	Group B
	20 units	3 units

According to Parfit's description, given this choice, the strict egalitarian, concerned with the relative wealth levels, will opt for scenario 1, because the inequality between groups A and B is of 8 units, rather than 17 units. But what will the prioritarian choose? Prioritarians in interpretation a) (henceforth, 'PrioritarianA)' will opt for scenario 2, because even though the equality gap is larger, Group B (the worst-off group) receive more units of well-being. It can also be seen here why interpretation a) might seem to fit Parfit's description

[176] I do not think that it is clear which version of Prioritarianism is closest to Rawls' Difference Principle, and for this reason I do not consider this here, but I argue elsewhere (Read & Makoff, 2008) that Rawls' Difference Principle should collapse into a form of strict egalitarianism.

[177] As alluded to in section 4.4, sufficientarianism, as Page understands it, considers equality to be irrelevant so long as people "have enough", since, according to a leading advocate, Frankfurt, "If everyone had enough it would be of no moral consequence whether some had more than others" (Frankfurt, cited in Page, 2006, p86). This therefore also differs from what I have called "PrioritarianB". Page argues that Sufficientarianism requires "as many people as possible" to have "enough". Assuming a sufficiency threshold of 50 units, this would lead sufficientarians to prefer a "half at 60, half at 45" scenario, than a "half at 49, half at 46" scenario which is more equal, but where no-one quite has a sufficient level (p86). Whereas, PrioritarianB would give priority to those worst-off below the threshold, since their absolute wealth is lower. Additionally, I have conceived of PrioritarianB as defining a threshold that delineates those in poverty, whereas Page highlights that Frankfurt's sufficientarianism conceives of "Having enough" not in terms of "living a bearable life", but "leading a life that contains no substantial distress or dissatisfaction"; so the threshold would be located differently in the two cases.

of prioritarians as focusing on "absolute" poverty; for in scenario 1, Group B are, in absolute terms, poorer than in scenario 2.

What about prioritarians under interpretation b) (henceforth, 'PrioritarianB')? This will depend on the level at which 'being badly off' is defined. If the poverty level is set at 2 units or over, prioritarians under b) will also prefer scenario 2. For suppose the poverty level is set at 2.5. Then Group B in scenario 1 will be below the poverty level, and in scenario 2, they will be above it – scenario 2 is then preferable. However, if the poverty level is set at under 2 units, PrioritarianB will not have anything to say, morally speaking. For if what is morally relevant to distribution is attaining some pre-determined minimal standard of living, say, 1 unit, then in both scenarios, group B is above this level[178].

It is not clear to me which interpretation Parfit wants to take. Both interpretations could be taken to consider 'absolute' poverty – PrioritarianA because what matters is the absolute allocation of the worst-off group in comparison to their allocation under some other distribution, and PrioritarianB because the level of being 'worst-off' is fixed, absolutely. But in the case of emissions distribution, there are implications for how 'basic needs' might be understood as a principle. For, PrioritarianA will, given the zero-sum nature of the resource in question, collapse in practice into a strict egalitarian position, and 'basic needs' would, if understood according to PrioritarianA as 'the *most* basic needs', likewise become equivalent to the principle of 'capacity' (simply expressed and motivated differently). PrioritarianB, on the other hand does not seem morally or pragmatically satisfying, since it leaves open distributive issues once (and if) pre-determined basic needs/capabilities are met. I shall briefly explain why.

Beginning with PrioritarianA, it should be remembered that the difference in practice between this and strict egalitarianism is where there is a possibility that the worst-off group might receive increased absolute welfare, but the inequality gap would widen (and therefore, that relative poverty would increase). However, this is only possible if it is assumed that the total sum of resource to distribute can grow. But with emissions space, as with any finite natural resource, this is not the case (and in fact the total sum of resource will shrink as we lower the emissions cap). The situation will simply not arise where supporters of PrioritarianA could opt for an increased absolute welfare level where there

[178] In this regard, PrioritarianB is identical to sufficientarianism.

would be increased inequality (and therefore higher relative poverty), since this would imply an increase in the amount of resources. The only way to allocate more resources to the worst-off is to give less to others – which also decreases inequality.

Seen in this way, 'basic needs' could be seen as predominantly a strategy for achieving distribution according to 'Capacity', and equality of objective welfare. One begins with a collection of people, and a fixed amount of emissions to distribute. The worst-off group is then defined according to those with the lowest level of need satisfaction (or equivalent welfare measure) and they are allocated sufficient emissions (and/or alternative support) to allow them to reach above this level. What happens to the remaining emissions, once enough have been allocated to ensure basic needs of this worst-off group have been met?[179]. In this case there is a new 'worst-off' group (which may or may not contain members of the previous 'worst-off' group). The same rule would then presumably be applied in allocating sufficient emissions to them to lift them from their 'worst-off' position, in priority to allocating emissions to better off groups whose welfare level is significantly higher. And so on. At some point, emissions allocations run out; or at least, we risk not having sufficient emissions to prevent other groups from becoming 'worst-off' themselves. But at this point, the 'strict egalitarian' would also stop redistributing; it is, because of the zero-sum nature of the resource, as close to a position of equality (of objective welfare) that can be achieved with this resource[180].

It seems, therefore, that if 'basic needs' is understood according to PrioritarianA as looking at improving the *most* basic needs, then (in addition to what was argued under 5.1) it becomes equivalent to Capacity. However, perhaps it might be thought that PrioritarianA would not still be equivalent to 'Capacity' in practice. Possible reasons could include that even if the total amount of the initial resource we are distributing is fixed, the benefits that one could gain from this would not be 'zero-sum', because the possible benefits might grow (as, for example, new skills develop, practices are made more efficient, etc). I do not examine further these concerns, but I consider reasons for doubting this elsewhere[181]. But

[179] We should remember, of course, that the measure of standard of living is not, as in the simplified scenarios above, the same measure as the resource being distributed; as I argued in section 4, whilst we are distributing is emissions, what we consider as standard of living is the objective welfare (capabilities) that is supported by this resource.
[180] I say 'as close to' because the strict egalitarian(and likewise the prioritarian), if following my approach, would not seek to equalise(or prioritise) the resource itself, but the objective welfare that is supported by it, and this depends on resources other than, and factors other than, emissions allocations.
[181] For a fuller discussion see Read & Makoff, 2008.

even if this were the case, Prioritarian A will still be subject to the following concern affecting PrioritarianB.

This concern is that applying PrioritarianB to the case of emissions distribution would, for example, require allocating emissions (and other forms of support) to countries in such a way that all countries could meet a predefined level of basic needs (or basic capabilities), but would not require that inequalities in standard of living *above* this basic level be accounted for. And PrioritarianB seems to be closer to the version of prioritarianism behind 'Basic Needs' as a principle of equity for climate change mitigation. For the 'basic needs' principle in mitigation discussions does not offer the potential to look at the worst-off 'iteratively' but seeks either to define a threshold poverty level, below which 'basic needs' are not being met[182], or to define 'essential' uses for emissions[183].

But in this case, unlike for the principles considered so far, it will then have to address the question, as Shue puts it, of "from whom" we 'take' the extra emissions and extra resources that are used to ensure basic needs of other countries.[184] One response could be, "from those with the highest capacity", but this would require appealing to a further principle of equality, rather than priority. For, if there are countries with varying capacities above the threshold for 'basic needs' and the Prioritarian concern is to meet needs below some absolute level, then there is no moral difference in the variations between the others. It would be hard, I believe, to offer a convincing argument that there is no morally significant difference between distribution strategies above this level, when taking equally from countries barely surviving and those with the highest levels of wealth would impact far more heavily on the capabilities/ standard of living of those of a lower capacity. But whatever one's instinct on this, the primary concern here is that PrioritarianB**,** and associated 'Basic Needs' approach, is morally silent above this level, and would need supplementing via a further principle.[185]

[182] For example, the Greenhouse Development Rights' "development threshold", Baer et al, 2008, p41-44
[183] Shue, 1993, p42-43
[184] Shue, 1993, p50 distinguishes between "to whom" and "from whom" questions in theories of distributive justice. But, I suggest, with principles such as Capacity, and Equal Entitlements, the two will never become separated -they are contained within the principle. The questions become separate for *Shue* because he takes a prioritarian approach, considering a particular group of "victims" (p53) (i.e. those who are harmed by pollution, or those below a certain standard of living). In such a case, Shue's distinction is indeed useful, because it highlights the importance of the "from whom" issue which may well be overlooked by prioritarian approaches.
[185] Of course, in practice, because the level of the cap must now be set so low, allocating emissions (and other support) at a level that developing countries could meet their basic needs/ basic capabilities would not leave many emissions allowances 'left over' to distribute.

This is a reason to suggest that the 'Basic Needs' principle is not, on its own, as helpful a guiding principle as one might want; but it does not, so far, constitute a reason to reject the principle in favour of Capacity, since one could argue for other supplementary principles. However, the further problem lies in its concentration on absolute, rather than relative poverty. That is; that the size of the inequality between group A and B is not seen to be directly relevant to the poverty of group B. What matters is the 'absolute' level of group B's welfare. But there are strong reasons to suggest that 'relative' poverty is as important as 'absolute' poverty in understanding well-being (and that, therefore, the strict egalitarian position in any case better accounts for the relationship between well-being and inequality). These include the concerns expressed by the New Economics Foundation, who have suggested that;

> "people assume that it is only the absolute incomes of the poor which matter. Absolute changes in income are undoubtedly much more important at the bottom of the global income distribution than they are to the majority of the population of developed countries… But, even among the poor, relative incomes may nonetheless have some significance, as they do at higher absolute income levels, for example through their effects on social status and self-worth."[186]

This kind of point has also been made by Hirsch, who emphasises that the impacts of relative poverty are not simply 'psychological'. Many goods are, he argues, 'positional goods' because of 'social scarcity'; that is, "the good things of life are restricted not only by physical limitations of producing more of them but also by absorptive limits on their use"[187]. This means, he argues, that "Consumers individually find that their access to socially scarce goods and facilities, where these are attainable even in part through market processes, *is determined in accord not with absolute but with relative real income"*[188]. There are, in other words, social 'goods', which include resource access and high status jobs, but also social activities such as higher education, leisure pursuits, etc (which arguably constitute an important part of our well-being), which are inaccessible to the

[186] Woodward & Simms, 2006, p9-10
[187] Hirsch, 1976, p3. Examples include living in the suburbs, which, as they become more populated (as peoples absolute incomes rise), cease to function as suburbs but as urban areas, whereafter those with relatively higher income can afford to move still further out, and so on.
[188] Hirsch, 1976, p6. My emphasis.

relatively poor, no matter how high their absolute level of wealth[189]. Amartya Sen has also argued that, "relative deprivation of incomes can yield absolute deprivation of capabilities", though for the slightly different reason that, "In a generally opulent country, more income is needed to buy enough commodities to achieve the same social functioning"[190]

The idea implicit through these discussions is that inequality almost always leads to lower well-being when understood in its fuller sense (e.g. capabilities, including mental health, ability to take part in the community, activities, and so on). To use the terminology of capabilities; the increases in freedom of some to do and be various valuable things will impact on the existing freedoms of others – on their capability sets. The problem for PrioritarianB is, therefore, that there are good reasons to believe that the degree of the inequality will affect, in fact, will partly *constitute* the 'absolute' capability set (or objective welfare) of the 'worst-off' group. For this reason, I suggest that the PrioritarianB conception is fundamentally flawed, and, consequently, that 'Basic Needs' should be set aside in favour of a principle of Capacity, as discussed in section 4, understood according to a 'capabilities' or similarly framed 'needs' based conception of objective welfare.

6. Conclusions

I have argued that, of the four principles I consider here, 'Capacity', interpreted according to a 'capabilities' position (roughly as developed by Amartya Sen), should be the guiding principle of equity for a climate change agreement. Of the other three, I suggested that 'equal/comparable burdens' was flawed because it failed to conceptualise distribution in climate change mitigation as a resource-sharing issue, with 'emissions space' considered as a global commons resource. I then argued that equal (per capita) allowances, although the most obvious first attempt at a principle of equity that recognises the 'resource-sharing' context, could not be justified by any of the main positions in the 'equality of what' debate, even as a practical approximation, since it does not allow for the (relevant) existing inequalities in wealth between countries.

[189] Indeed, Wilkinson and Pickett, 2009, provide substantial evidence to show that a society's "poor health and social problems" are "related to inequality rather than to average living standards" (p20).
[190] Sen, 1999, p89.

I suggested that this was the motivation behind the Capacity principle, which could be justified by any of the main positions on equality. However, I argued that of these, equality of objective welfare was the best way to interpret the Capacity of a country, and guide the distribution of emissions. I examined how the 'capabilities' approach might offer an appropriate way to understand objective welfare, although I suggested that a 'needs' based understanding could be similarly developed if it was not specified in terms of particular (contingently useful) resources. Lastly, I explained why 'Basic Needs', as a prioritarian variation on 'Capacity' that might equally meet the concerns of sections two and three, was problematic. I considered two ways of interpreting this prioritarianism. I found both to be problematic, with one collapsing back into a principle of 'Capacity' and stricter egalitarianism, and the other underestimating the importance of relative poverty.

I have not here examined a fifth principle, "Historical Responsibility", which I have argued elsewhere is only egalitarian in so far as it coincides with the capacity principle.[191] However, I will briefly sketch the argument. One of the significant challenges for Historical Responsibility is how moral responsibility can be attributed across generations, or even within a generation if different people are in government. Gosseries convincingly argues that current generations can be morally responsible because of "transgenerational free-riding", i.e. that they have benefited from past harmful emissions. This implies, I have suggested, that only historically high-emitting countries that are still benefiting should be liable now, making it mostly co-extensive with the Capacity principle. However, I further argue that this outcome of the Historical Responsibility principle only seems equitable and therefore receives the support it does because of historical circumstance; "the pre-existing wealth differentials between higher and lower-emitting countries"[192] which were widened by transgenerational free-riding, and which the Historical Responsibility principle would serve to reduce. Had free-riding countries been poorer, and those harmed richer, application of the principle would not be egalitarian[193]. It is therefore only the correlation between Historical Responsibility and the Capacity principle which makes the former a plausible principle of equity, and it cannot then be relied on as the primary principle of equity in a mitigation agreement.

[191] Makoff, 2011
[192] Makoff, 2011, section 3.
[193] As I point out there, this is an implausible scenario because of the relationship between national wealth and historic emissions. But the thought experiment functions to highlight the structural features that make "historical responsibility" appealing to egalitarians, contingently.

My resulting conclusion of this chapter, that 'Capacity' should be the guiding principle of equity for an international agreement on climate change mitigation, should, to emphasise, be understood as a guide rather requiring literal equality of objective welfare, as suggested at the end of section 4. My aim was to make explicit what I believe we *should* mean by describing a climate change mitigation agreement as 'equitable', and the considerations we should bring to bear in evaluating competing proposals. There may be different ways to implement the criterion, as suggested earlier; rather than accommodating for unequal capacities through (inversely) unequal emissions distribution, existing inequalities may be better accommodated through additional distribution of the associated financial costs of keeping/reducing to a lower allowance, or increasing other kinds of support between nations. In the next chapter, I consider how one way of doing this, carbon trading, has been argued to preserve equity through the distribution of costs, whilst determining the allocation of emissions permits themselves through efficiency. This is therefore presented as a way to reconcile the criteria of efficiency and equity which can otherwise conflict. However, I argue there that in such a model the equity is in fact undermined; if the demands of equity via the principle of Capacity are to be met through cost-distribution, it should not, therefore, be through this mechanism.

Chapter 4 - Efficiency.

0. Introduction.

In chapter 1 I argued that efficiency should not be prioritised over, or a replacement for, the criteria of equity or ecological effectiveness. Rather, it should be understood within the context of, limited by and compatible with these first two criteria. I now consider how best to interpret the criterion of efficiency in such a framework. I begin by setting out conventional economic interpretations of efficiency, which, despite common protestations of neutrality to the contrary, are heavily value-laden. I highlight how these narrow economic conceptions of efficiency bring the criterion into conflict with the criteria of ecological effectiveness and equity as suggested in chapters 1 and 2[1]. I shall then suggest how efficiency might instead be construed as guided by these criteria, to reflect the re-embedding of the economy within social and ecological spheres. I consider the main way in which this is supposedly achieved by placing limits on its operational space through tradeable carbon permits. I discuss the significant criticisms of the practice, which imply that here efficiency is still in tension with both equity and ecological effectiveness. I then consider alternative ways in which efficiency might be redefined conceptually beyond merely placing limits on its operation, such that it is truly re-embedded and complements rather than undermines these criteria. Lastly I draw out the implications for policy.

1. Conventional economic approach to efficiency.

1.1 Conventional economic definitions of efficiency.

Efficiency as a criterion is more often than not assumed to be sufficiently self-evident so as not to require specific definition, unlike, for example, equity[2]. This may in part be a symptom

[1] Chapter 1, section 3 and Chapter 2, sections 2.2 and 3.2.

[2] For example, Rose and Stevens, 1993, examine the "efficiency and equity" in tradeable emissions permits, and whilst they explicitly consider different equity principles, highlighting that "there is no consensus on a single best definition of equity", there is no parallel exercise for efficiency, and they launch straight into "a theoretical analysis of efficiency implications" of carbon trading (p118)

of its failure to be recognised as a normative concept. As has been suggested in chapter 1, efficiency is often assumed to be a feature of the uncontestable standards of supposedly value-neutral economics, rather than explicitly acknowledged as a value, despite its prescriptive use. It is worth bearing this in mind since, as I suggest in section 3.1, it is unclear what its moral status is or how it is intended to be justified. Either way, it is clear from the different interpretations of efficiency that emerge even within conventional economic writings, that Le Grand is correct to observe that "The interpretation of efficiency is as much a complex and value-laden business as the interpretation of equity"[3]. I consider some of these alternatives in 3.1, but I shall now briefly summarise those distinctions which already exist in neo-classical economic interpretations of efficiency in climate change policy.

Strictly speaking, when academic neo-classical economists use the term 'efficiency', this refers to a particular understanding of allocative efficiency - pareto optimality[4]. That is, an allocation of resources such that it is "impossible to make one individual better off without making another worse off"[5]. It often appears to be understood this way with reference to climate change policy, in so far as it is defined at all. For example, Hamaide and Boland, who I return to in 1.2, look for a pareto-optimal distribution of mitigative effort between countries[6]. They draw on the Kaldor-Hicks variant of pareto-optimality[7] to propose a compensation criterion, although this is normally only hypothetical. That is, they argue for side payments to be made to parties who would otherwise lose from economic impacts of mitigation, so that "no nation would be expected to accept an agreement if it is not at least as well off with it as without it."[8]. Hamaide and Boland see "pareto optimality" in international climate change mitigation efforts as a way of "maximizing total net benefits" and therefore equivalent to "global economic efficiency", whereby "the marginal social benefit of each region's abatement (defined as the marginal benefits accruing to each region summed over all regions) [is] equal to that region's marginal abatement cost."[9].

[3] Le Grand, 1990, p566
[4] See e.g. McDowell et al, 2009, p183. Also Begg et al, 2005, p260-270
[5] Le Grand, 1990, p563
[6] Hamaide and Boland, 2000.
[7] Highlighted by Padilla, p531
[8] Hamaide and Boland, 2000, p254
[9] Hamaide and Boland, 2000, p242

This also relates, therefore, to the further "cost-minimisation" approach to efficiency in climate change literature. This can be understood in two ways, which are often conflated, although it is unclear how distinct they in fact are in practice. The first variant relates to the welfare-economic idea of minimising overall costs, or maximising net benefits/utility, and is used to determine the optimal climate target[10]. For example, Aldy et al assert that "A global climate policy that achieves maximum aggregate *net benefits* is said to be *efficient*"[11]. This "dynamic efficiency" is different from "cost-effectiveness", which for Aldy et al, is used as a distinct criterion advocating "the least costly means of achieving some given target or goal". But for some, this criterion of "cost-effectiveness" can constitute "efficiency", apparently drawing on the economic concept of *productive* efficiency, since meeting a CO_2 target at "least cost" is taken to mean "attaining efficiency in the production of CO_2 abatement"[12]. This is, therefore, the second variant of "cost-minimisation" approach to efficiency. "Cost effectiveness" forms part of the UNFCC statement, which recommends that "policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost"[13]**,** and is often taken to be the reference point for *efficiency* in climate change policy[14] . However, this idea of cost-effectiveness is confusingly sometimes understood straightforwardly in terms of *overall* cost minimisation over time (i.e. conflated with Aldy et al's concept of "dynamic efficiency"), largely irrespective of how those 'costs' contribute towards other, non-financial 'outputs'. For Shukla, for example, the UNFCC statement is taken as an aim simply "to ... minimize the cost"[15] or "to minimize the total burden"[16], (i.e. considering the total costs and benefits rather than the cost of achieving a particular, pre-defined goal) and states accordingly that "Efficiency in the context of climate change means minimizing the extent of the climate change burden and is synonymous with cost-effectiveness"[17].

[10] I.e. to "subsume" questions of "scale... under allocation", Daly, 1997, p53
[11] Aldy et al, 2003, p375, emphasis in original.
[12] Rose and Stevens, 1993, p124
[13] UNFCC, 1994, Article 3.3
[14] E.g. Shukla, 2005, p122.
[15] Shukla, 1999, p3
[16] Shukla, 2005, p122. See also Bertram, who similarly understands efficiency in terms of "cost effective abatement options" - Bertram, 1992, p425
[17] Shukla, 2005, p122.

It may be thought that understanding efficiency as "Cost-effectiveness" of achieving a given target *should* be distinguished from overall cost minimisation/ benefit maximisation, even if this is not always recognised in practice. For, such a common-sense idea of efficiency as minimising a system's waste can seem intuitively sensible and entirely compatible with environmental and ecological outlooks[18]. Why use more resources than is necessary to achieve the same outcome? This is, in essence, to retain the idea of efficiency as cost-minimisation, but to constrain or limit its operability by other goals, which determine the climate target. I discuss the problems with this idea, which I term "re-embedded efficiency", in section 2, and why I do not believe it constitutes a significantly different concept. Its common-sense appeal is, I will suggest, misleading since in fact a lot turns on what counts as waste (or "cost") and how it is measured, as I consider in section 3.

Other definitions of economic efficiency are also evident in the literature. Efficiency as cost-minimisation can then further become synonymous for some authors with maximising economic growth, as Le Grand has identified[19]. Alternatively, efficiency has been described as "self-regulation", i.e. where the system works automatically towards agreed goals requiring minimum external interference/ correction, as implied by Bertram[20]. However, this is primarily a supplement to or mechanism for achieving the core interpretation of efficiency as cost minimisation or utility maximisation. Similarly, Philibert's "four... dimensions of flexibility" ("'where', 'who', 'when' and 'where to' flexibilities")[21] are largely a rebranding of the 'dynamic efficiency' variant of economic efficiency, such that each 'dimension' is sensitive to and determined by the changing costs and benefits of DACC mitigation.

I go on to consider alternative approaches to efficiency in 3.1, which may suggest a better treatment of efficiency, understood as a function. But first I will highlight how the primary conventional concepts of economic efficiency come into conflict with the other criteria for DACC, before considering attempts to make them compatible in section 2.

[18] Indeed, Stein credits the "contemporary environmental movement" post the 1962 publication of Rachel Carson's Silent Spring, for the emphasis on ""waste", then of "conservation", and then of efficiency as a means of protecting and preserving our natural heritage" through the "efficient use of environmental resources". Stein, 2002, p50.
[19] Le Grand, 1990, p561.
[20] Bertram, 1992, p435.
[21] Philibert, 2006, p29.

1.2 Conflicts with other criteria.

These approaches to efficiency create problems for using efficiency as a criterion for an international agreement on DACC, since it is then in conflict with the first two criteria. As has been suggested in previous chapters, efficiency can in fact amount to a competing alternative criterion to ecological effectiveness and equity. That is, it represents an alternative way of addressing their concerns - for the former, in deciding emissions limits and in the latter determining distribution.

As was considered in chapters 1 and 2, CBA has been used to attempt to determine the "globally optimal timepath of emissions mitigation"[22], i.e. to promote "dynamic efficiency". By economically aggregating the economic costs and benefits to different regions across time from the impacts of DACC, the total costs of different levels of mitigation can be compared to determine which mitigation pathway lowers overall costs. The appeal is to be able to offer a non-subjective assessment of the point at which DACC becomes dangerous, which might otherwise be contentious. However, as I argued in chapter 1 section 3.1 and chapter 2, section 3.2, this commensuration process ignores important qualitative distinctions between different kinds of cost and benefits, including how fundamental they are to the survival of human societies or the wider ecological community.

That this is in conflict with the concerns of ecological effectiveness as I considered in chapter 2 is not denied by advocates of cost-minimisation such as Philibert, who proclaims that the importance of "cost-effectiveness"(here, again, conflated with dynamic efficiency) as a "long-term issue" lies in "not so much 'getting a given environmental result for the cheapest possible cost' than 'getting the best environmental results for a given expense'"[23]. In other words, the need for a limit is seen as relating to expenditure *rather* than the environmental or ecological impacts of DACC. Efficiency is thereby prioritised over, and at the expense of, ecological effectiveness.

[22] Toman, 2006, p369
[23] Philibert, 2006, p31

This was the concern of Meyer and others from the Global Commons Institute who attacked "Global cost-benefit analysis" and the "quest for efficiency... to reveal the most cost-effective climate policy"[24] which dominated international negotiations on climate change. Meyer argues that "the economists' aim was to weigh the damage costs likely to result from climate change against the costs of cutting emissions so as to prevent these damages" and that when "their calculations showed that the cost of preventing climate damage was greater than the cost of the damage itself, they began advocating what was, in effect, the sale of planet to the economy"[25].

Similar problems arise in relation to the equity criterion. Even within a fixed global cap, efficiency is often likewise presented as an alternative to principles of equity for distributing emission permits between countries (or industries). Chapter 3 considered which principles of equity a global distribution of a yearly emissions budget should adhere to. But addressing the concerns of allocative efficiency so that costs are minimised requires that where emissions reductions occur depends on where it is cheapest to do so - not based on the capacity of that society to achieve a decent level of well-being, or on moves to EPCA emissions shares, as were considered in chapter 3. For example, if efficiency is understood in terms of pareto optimality as cited above in the case of Hamaide and Boland, a country's financial contributions and quantity of emissions reductions are based on the requirement for each country to be better off with an agreement than without, rather than according to principles of equity. Similarly, if efficiency is interpreted simply as "least cost", then what Philibert has referred to as "where flexibility" can be introduced to reduce "the costs of achieving a given short term target, in allowing emission abatements to take place wherever they cost the less"[2627].

However, this brings it into conflict with equity. With regards to equity as historic responsibility, as Brown has argued "Those seriously harming others have no right to

[24] Meyer, 2000, p47
[25] Meyer, 2000, p51
[26] Philibert 2006, p29
[27] The idea of "least cost" is in itself dubious in this context, since many apparent costs have other benefits, e.g. creating jobs through establishing new industries (Green New Deal Group, 2008), or health benefits through reduced air pollution (Toman, 2006, p375)

demand, as a precondition for their stopping their injurious behaviour, that the victim agrees to a solution designed to minimise the assaulter's cost."[28]. And with relation to equity as Capacity and equality of objective welfare, the distribution of emissions reductions on this basis does not distinguish the effects of these reductions on different countries, as Shue has highlighted:

> "To suggest simply that it is a good thing to calculate cost-effectiveness across all sources of all GHGs is to suggest that we ignore the fact that some sources are essential and even urgent for the fulfillment of vital needs... What if, as is surely in fact the case, some of the sources that it would cost least to eliminate are essential and reflect needs that are urgent to satisfy...?"[29].

In this way, efficiency present a *competing* distributive principle, which does not take on board Shue's distinction between "survival" and "luxury" emissions or other considerations of equity as discussed in chapter 3.

And, more often than not, efficiency simply provides an alternative for both distribution *and* scale; equity and ecological effectiveness. Hence Shukla has noted that since neo-classical economics "assumes existence [sic] of efficient market dynamics universally... climate change being a global and long-term problem, the search for efficiency leads naturally into a where and when flexibility... i.e. to decide the location and time of mitigation actions which equalise the marginal costs across the nations and in time, and thereby minimise the global mitigation cost, i.e. the size of the burden" with the "distribution of mitigation burden... considered a separate problem, merely a secondary side-payment issue"[30].

However, efficiency need not represent an alternative. It perhaps plausibly could be compatible or additional, so long as it operates within limits that are set by equity and ecological effectiveness. In other words, if it seeks instead to minimise the cost of a pre-

[28] Brown, 2002, p192. It may be argued that suddenly "stopping their injurious behaviour" - reducing emissions at the rates required without trading - has other injurious consequences. But this should be accounted for under the process for determining the "precautionary" element of ecological effectiveness criterion - the risks incurred by the precautionary action, as well as the equity criterion which should look at the effects on well-being of different countries of the distribution of emissions limits at particular times.
[29] Shue, 1993, p55
[30] Shukla, 1999, p3

determined ‘ecologically effective’ mitigation target and ‘equitable’ international emissions distribution, akin to Aldy et al's “cost-effectiveness” criterion.

2. Re-embedding efficiency.

2.1 Attempts to re-embed conventional economic efficiency.

I suggested in chapter 1, following Daly and Meyer, that efficiency as a criterion must (instead) be understood in the context of - guided by - the criteria of ecological effectiveness and equity if the three are to function as compatible criteria for an international agreement on climate change mitigation. Can this re-embedding be accomplished through retaining but limiting the operation of the conventional economic idea of efficiency? This seems the obvious and intuitive approach; for efficiency to require us to minimise the costs or maximise the utility of meeting *particular* emissions targets and distributions, as pre-defined by the criteria of ecological effectiveness and equity. Both Daly and Meyer amongst others conceive the task in this way. They seek to achieve it through limiting the space within which allocative efficiency can operate, a space defined by equity and ecological effectiveness (for Daly - distribution and scale[31]). The paradigm case for this is tradeable emissions permits[32]. I shall explain in 2.2. why this is ultimately unsuccessful as a way to re-embed the efficiency criterion, where I examine the nature of the problems with and criticisms of carbon trading. Rather, in section 3, I pursue an alternative understanding of re-embedding efficiency which does not retain the conventional economic conceptions. For now, however, I shall examine the way in which Daly and Meyer's strategy is meant to operate as a means of making the criterion of efficiency compatible with the other criteria.

Daly has argued that although allocative efficiency for any resource is best promoted by the market, “scale is not determined by prices, but by a social decision reflecting ecological limits. Distribution is not determined by prices, but by a social decision reflecting a just distribution

[31] These are Daly's parallel concepts, see Daly, 1997, p51 and chapter 1 part C where I discuss this.
[32] Indeed, Daly describes it as “truly a paradigm for many sensible policies”, as a way to separately address issues of scale, distribution and allocation Daly, 1997, p56

of the newly created assets. Subject to these social decisions, individualistic trading in the market is then able to allocate the scarce rights efficiently"[33]. He suggests, therefore, that questions of scale and distribution (which relate to ecological effectiveness and equity) should be determined first and "imposed on the market in aggregate quantitative physical terms", which allows the market to promote efficiency within these narrower confines and "achieve an optimal allocation of resources"[34]. Daly's suggestion is that tradeable carbon permits are the paradigm case of re-embedding efficiency in this way; "a beautiful example of the independence and proper relationship among allocation, distribution, and scale"[35]. This operates through first placing a global cap on emissions, determined by the judgements of a safe level/scale of emissions (or by, as I have argued in chapter 2, one's interpretation of 'ecological effectiveness'). The global emissions budget is then distributed between countries as emissions permits according to one's principle of equity so that concerns of fairness in distribution are met. But, having achieved an equitable distribution, permits can then be traded between countries, allowing, it is argued, for efficiency but without compromising climate change mitigation targets or international justice.

Dworkin has argued similarly on a local economic level that trading can allow efficiency to be compatible with equality. He acknowledges that the market is often seen as an "enemy of equality, largely because the forms of economic market systems developed and enforced in industrial countries have permitted and indeed encouraged vast inequality in property"[36]. However, he suggests, so long as the market exchange system begins with an equal distribution, and "people enter the market on equal terms"[37], the market mechanism preserves equality and improves efficiency[38].

[33] Daly, 1997, p53
[34] Daly, 1993b, p349
[35] Daly, 1997, p52
[36] Dworkin, 1981b, p284
[37] Dworkin, 1981b, p289
[38] This is because, he argues, through competition in demand the market automatically includes the cost to others in the price of a good- if the price is higher, it is because more people want it, and assuming everyone starts on an equal footing, those that need the good more will then pay more. This, he suggests, therefore places limits on what each person can fairly use (see in particular Dworkin, 1981b, p287-289). I think this dubious for various reasons (e.g it does not account for other personal inequalities, manipulation, how much people *need* etc...), but will not examine this here.

It is along these lines that Meyer's proposal of Contraction and Convergence as an international solution to DACC is formulated. Meyer suggests that the "emissions permissible" under a "legally binding cap" can only be traded once they have been "predistributed"[39], which he argues should be on an equal per capita basis (as discussed in chapter 3, although such predistribution could be carried out according to any principle of equity), since "the world's atmosphere belongs equally to everyone if it belongs to anyone at all". This equitable predistribution of "property rights to use the atmosphere" is for Meyer a precondition for trading, since "you cannot trade what you do not own, and ownership is impossible without limits"[40]. Similarly, Shukla argues that "justice" is not just a "virtue" of a climate change agreement, but "the engine for ensuring universal cooperation – the necessary *condition* for efficiency"[41]. Meyer believes that this "management [of emissions] by quotas is rationing" and "subordinates the growth economics of efficiency... to the global politics of precautionary limits and equity"[42].

Even Zenghelis and Stern,[43] more conventional economic writers, argue that:

> "A cap-and-trade system is appropriate to manage the risks of climate change by imposing an absolute limit on emissions, consistent with the scientific conclusions of the risk of catastrophic climate change (effectiveness). International emissions trading would also reduce the cost of mitigation by allowing emission reductions to occur in whatever sector or country would be least costly (efficiency). The benefits of carbon

[39] Meyer, 2000, p55

[40] I do not discuss, in this thesis, the implications of the concept of 'ownership' here. The idea that the atmosphere (or indeed any part of our ecosystem) can be 'owned' is ethically controversial. Not least in the context of co-managing a global commons, where the model is precisely in opposition to individual private ownership, as considered in chapter 1. For in this case it is misleading to consider permits as ownership of part of the atmospheric commons, since they would be reduced year on year, and may change according to the demands of equity. Therefore, I do not think a "cap and trade" or even a non-tradeable rationing system *need* conceive the permits as 'owned' in the way that Meyer implies, and can simply be understood as "temporary [use] rights" as Brown has suggested (Brown, 2002, p199)..

[41] Shukla, 2005, p123, my emphasis.

[42] Meyer, 2000, p55. Although not all advocates who frame the problem in this way will also agree on the implications for general "growth economics". E.g. Agarwal, who also sees cap-and-trade as a means of meeting "three criteria" of "ecological effectiveness... economic effectiveness" and being "socially just and equitable towards all countries", sees the aim of the system as being to "create a framework for global cooperation so that the world can move as quickly as possible toward a world economy that can keep on growing by using renewable energy." (Agarwal, 2002 p388). Similarly Zengelis and Stern, cited next.

[43] Zenghelis & Stern, 2009. See also Stern, 2008.

trading could be high, generating private sector financial flows to developing countries which could be used for low-carbon development (equity).”[44].

What this highlights, however, is that under cap-and-trade, the demands of equity are met not by actual equitable emitting activity, since the location of emissions reductions (and therefore also the continuation of emitting activity) is ultimately determined by the market. Rather, equity is promoted by the equitable distribution of the *cost* of mitigation efforts, to be born primarily by richer countries through permit trading. There is a separation between where the mitigation occurs (determined by efficiency) and who pays for it (determined by equity)[45].

Such a trading system in carbon permits is therefore suggested to promote efficiency in terms of *both* minimising cost and moving to a pareto efficient distribution because it makes the overall cap cheaper for all parties compared with their costs otherwise in meeting their obligations for emissions reductions. Lohmann (a critic of carbon trading, who I return to in 2.2) has explained how for two parties trading emissions the theory of trading implies lowered costs of emissions reductions[46]. We can, he says, imagine a cap placed on two parties, A and B of “100 tonnes annually”, under which each must limit their emissions to 50 tonnes. Prior to this, “A and B each produced 100 tonnes of pollution a year”. If, however, “it is cheaper for B to reduce its emissions to zero than it is for A to reduce its emissions at all”, then emissions trading will “allow B to make A’s reductions for A” by allowing A to pay “B to reduce B’s emissions to zero”. Both A and B benefit, since if “the price B charges for the necessary pollution permits is more than B’s cost of reducing emissions to zero, yet less than A’s cost of reducing emissions to 50 tonnes, B makes money off the deal at the same time that A saves money. Both come out ahead – yet the same environmental goal of limiting overall pollution to 100 tonnes a year is met.” As such, efficiency - here both in terms of pareto optimality and cost-effectiveness - is maximised, in theory without sacrificing either equity or ecological effectiveness[47].

[44] Zenghelis & Stern, 2009, p309
[45] As alluded to in chapter 3, section 1.1.
[46] Lohmann, 2008b, p5
[47] Indeed, the famous Coase Theorem argues that, so long as there are no transaction costs, trading in an externality will always lead to an efficient outcome, no matter what the initial distribution of property rights: this means, in theory, that equity and efficiency should be compatible.

Although this means that some parties can continue polluting, the argument runs, they can only do so if permits are bought from other parties who pollute less - so long as permits are kept within the total cap which is continually lowered, ecological effectiveness will be, it is argued, preserved. And although there is not a starting point of *total* equality of resources, as in Dworkin's approach, this is not thought to undermine equity with respect to climate change mitigation so long as the money paid to those selling their emissions permits adequately cover costs of losing their share of the atmospheric commons. Indeed, this is argued to be more equitable because of the supposed potential for massive financial transfers from the North to the South. Hence Meyer has argued that "This feature would lead to a steady flow of purchasing power from countries that have used fossil energy to become rich to those still struggling to break out of poverty" and would "thus not only shrink the gap between the rich and poor but also encourage the South to develop along a low-fossil energy path"[48].

If this is true, there seems no reason to prevent industrialised countries from meeting some or all of their mitigation burden (decided previously by the equity criterion) through trading permits, and instead funding emissions reductions elsewhere. This was a possibility raised in chapter 3[49] and seems on the face of it to be compatible with equity if the concern of equity is equality of objective welfare and not of the resource itself (i.e. the earth's absorptive capacity for emissions). For, I argued there that this resource is valuable to use only in so far as it contributes to well-being, and not for its own sake. However, meeting the emissions burden through trading permits seems for many to be ethically dubious, since it is unclear that equity *is* in fact preserved once permits are traded. It is unclear that equality of objective welfare vis a vis emissions space *has* been preserved if some countries (or companies, industries, groups) are permitted to continue high-emitting, polluting activity simply because they are paying for it. The lifestyles and standards of living being pursued by countries continuing higher-emitting activities would be substantially different, and, by definition, inaccessible to other, poorer nations. If those continuing high-emitting activities also have more economic power, attainment of which continues to depend on higher-emitting activities, there may also be a risk

[48] Meyer, 2000, p20
[49] Chapter 3, section 4.5

that a cap-and-trade system would still 'lock-in' global inequality in the way that was considered in chapter 3.[50]

The concern is, therefore, whether paying for reductions elsewhere rather than making domestic reductions *does* continue to fulfill the criterion of equity. And, as I shortly consider in 2.2, there are reasons to doubt that this is the case. Indeed, this approach to promoting efficiency through carbon trading seems to undermine both criteria of equity and ecological effectiveness. The question is how far this is a result of current practice, or whether they are in theory reconcilable.

Beforehand, it is worth briefly considering another approach which may imply a compatibility between pareto optimality and equity in distribution. It should be recalled that there is a difference between pareto optimality and pareto improvement, as Vatn has pointed out[51]. Whilst the latter implies that "the utility of some agents can be increased without reducing the utility levels of others"[52], pareto optimality is a distribution such that no such improvement can be made. As Vatn then highlights, any potential conflict between the latter and fairness of the distribution could be "circumvented by presuming the distribution to be optimal at the outset"[53]. Rawls also takes this approach with regards to the efficiency of just (rather than equitable) distributions[54]. He argues that there exist a variety of equally efficient (which he defines in terms of pareto optimality[55]) distributions of goods, and that whilst some of these efficient distributions will be unjust, if we "find a conception of justice that singles out one of these efficient distributions as also just... we shall have gone beyond mere efficiency yet in a way compatible with it"[56]. Rawls' own principle of justice, the difference principle, then defines a just subset of efficient distributions for Rawls. Because when it "is fully satisfied, it is indeed impossible to make any one representative man better off without making another

[50] Chapter 3, section 4.1
[51] Vatn, 2002, p151, (citing Griffin, R.C., 1995, On the meaning of economic efficiency in policy analysis, *Land Economics*, 71, 1-15).
[52] Vatn, 2002, p150, footnote 5.
[53] Vatn, 2002, p151
[54] Although NB Rawls is considering "an arrangement of rights and duties in the basic structure" of society; Rawls, 1972, p70.
[55] I.e. "an efficient distribution is one in which it is not possible to find further profitable exchanges" such that one person's "prospects" cannot be improved without "lowering the prospects of others". Rawls, 1972, p70
[56] Rawls, 1972, p70

worse off, namely, the least advantaged representative man whose expectations we are to maximize." and is therefore "consistent with efficiency, at least when the two principles are perfectly fulfilled."[57].

If so, then it may seem plausible that an equitable distribution of the kind I am considering with regards to emissions space is also already pareto efficient, since any further exchanges would move away from equity and thereby make some worse off[58]. This would be true even if moving to that particular distribution from a former one would not be a pareto improvement, since one can move from one pareto efficient situation to another. How far it is the case that any further trading after an equitable distribution will *necessarily* involve a move away from equity in this way is beyond the scope of this thesis, although I examine reasons to think that it *can* undermine equity[59] in 2.2[60]. However, even if so, it would not save the efficiency criterion: rather it would become effectively redundant, since it would be automatically fulfilled by the equity criterion. And this is not in fact how the efficiency criterion has in fact been understood: pareto optimality is a separate allocative efficiency criterion and the potential for further voluntary market exchanges is taken as a sign that pareto improvements are still possible. Therefore, I focus on the primary approach to compatibility between efficiency and the first two criteria – re-embedding efficiency (as either pareto optimality or cost-minimisation) through the paradigm case of carbon trading.

[57] Rawls, 1972, p79

[58] This would be so if the resources in question were zero-sum – i.e. one party only gains at the direct loss of another, *or* if relative wealth counts at least as much as absolute wealth (see chapter 3, section 5.2 regarding relative poverty), such that even if absolute levels rise, the rise in inequality renders the less wealthy party even worse off than at a lower but more equal absolute level of wealth.

[59] Which is sufficient for my purposes in demonstrating that re-embedding efficiency along the lines of the Daly-Meyer approach does not succeed in fully constraining efficiency within the bounds of equity and ecological effectiveness.

[60] I am tempted, in section 2.2. to make this stronger claim. That is, that if the point of trade is to reduce costs for those involved in the exchange (i.e. A won't buy additional permits from B rather than reduce its own emissions by a corresponding amount unless it is thereby cheaper to do so), the relative levels of resource-use or well-being between A and B, or between either party and others has changed, and it does not preserve the equity intended by the predistribution: slightly more, in the short-term has been gained/ less cost incurred. This relates to the concern regarding (non)commensurability – permits/emissions space are *not* totally equatable to or fully commensurable with financial value. They have different 'use values', to use Marx's term. Whilst this is precisely the purpose of exchange (if they were identical there would be no reason for exchange), it means that it does not leave the relative positions of the parties in the exchange untouched. However, defending this fully would detract from the main thrust of the thesis (i.e. in considering how trivial or significant the changes are), so I do not pursue this here, although it does, I believe, warrant further enquiry. NB this is also a different point to Nozick's "Wilt Chamberlain" scenario: there the focus is on the voluntariness of an exchange being in conflict with an equitable outcome, but there is no assumption that both sides are meant to gain to the same degree from the exchange, as is implicit in the case of carbon trading.

2.2. Problems with merely 'embedded' efficiency - carbon trading in theory and practice.

Increasing criticisms have been launched against the ability of carbon trading to produce both the scale of emissions reductions needed and climate justice. The emerging question is how far these criticisms bite primarily against the way that *current* carbon trading schemes have been operated and how far they imply further/deeper problems with carbon trading in principle. That is, in the terms I have been setting out, how far they also undermine the idea that carbon trading can, even with appropriate reforms, allow efficiency to be promoted at the same time as equity and ecological effectiveness.

It seems clear that current trading schemes are in practice not operated in accordance with the theory examined in 2.1. Schemes such as the EU Emissions Trading Scheme (ETS - used between companies rather than nations) ignore the approach to trading advocated by Daly and Meyer for a fixed emissions cap and equitable predistribution of emissions. They do not in fact operate under a fixed cap for the region. Rather, as critics have highlighted, additional permits are distributed in response to industry lobbying[61], so that the total quantity of emissions is not capped. And flexibility and offsetting mechanisms have allowed companies to meet quotas through funding dubious emission-reducing projects outside of the loosely-capped region so that emissions within the region have not fallen at all. Ecological effectiveness, in other words, has been totally undermined. And distribution has been far from equitable, with permits grandfathered - distributed to companies functioning under the scheme according to current rather than equitable usage of emitting activities - for free, generating "windfall profits" for the highest emitting industries who have maintained their emissions levels[62]. Organised in this way, they, like the Kyoto flexibility mechanisms, allow "questions of efficiency to trump principles of distributive justice"[63].

In so far as they go, such arguments can be taken to imply that current carbon trading schemes have simply not been implemented appropriately to re-embed efficiency. As Lohmann and others[64] have pointed out, these problems have largely led to calls for reform rather than

[61] Bohm & Dabhi, 2009, p15, see also Scott-Cato, 2009, p110
[62] Bohm & Dabhi, 2009, p15,
[63] Brown, 2002, p192 on the Kyoto flexibility mechanisms and trading scheme.
[64] Clifton and Cullen, 2009, p38

abandonment of carbon trading. These reforms often attempt to preserve equity and ecological effectiveness. For example, Brown emphasises the need for an equitable predistribution of permits, and reforms to the Clean Development Mechanism (CDM) to prevent "rich nations" from purchasing "the cheapest reductions while leaving the poorer nations with more expensive reductions", which is risked when rich nations seek projects that "reduce the greatest amount of greenhouse gas emissions at the lowest possible price"[6566]. But the question, for Lohmann, is "whether they [carbon markets] could ever work"[67]. For as is argued by Lohmann and Clifton and Cullen[68], there are reasons to think that even such reforms would be inadequate. Their concerns, along with other recent work, provide reasons to believe that carbon trading would still risk both equity and ecological effectiveness. This, I will argue, suggests that the theory behind carbon trading is flawed in representing it as a means to promote and conceptualise a re-embedded efficiency criterion[6970].

Why might ecological effectiveness be undermined even by reformed carbon trading, despite emissions being capped? The one key emerging concern is that where emissions are reduced matters both directly and indirectly from the point of view of ecological effectiveness. The former is less widely acknowledged. It is ordinarily claimed that where emissions are released or reduced does not matter from the perspective of reducing atmospheric concentrations and mitigating DACC[71]. However, there is some evidence that in fact, emissions reductions in different parts of the worlds can have different climatic effects. Berntsen et al highlight that

[65] Brown, 2002, p194

[66] Similarly, Agarwal, 2002, argues that "what developing countries should not accept is a principle of emission trading built solely on the argument that they provide a lucrative opportunity today to reduce emissions cheaply"(p388); rather, emissions should be capped and then distributed "equally among all people of the world"(p387). And Clifton and Cullen, 2009, p38 list a range of reforms that have been proposed.

[67] Lohmann, 2008b, p2

[68] Lohmann, 2008b, passim and Clifton and Cullen, 2009, p38-42

[69] Lohmann and also criticise it for other reasons , e.g. infringement of local ways of life, destruction of local environment/other environmental problems. Lohmann, 2008a, p362-364

[70] The boundary between theory and practice seems in any case unclear, and the suggestion that something problematic in practice would be possible 'in theory' is unhelpful if the latter involves abstraction to such an extent that it could never bear any significant relation to how the world operates 'in practice'. (Indeed, these are precisely Daly and Cobb's criticisms of the kinds of abstractions that operate in neoclassical economic theory surrounding the market; the "fallacy of misplaced concreteness". See Daly & Cobb, 1990, p35-43). In this case, for carbon trading to successfully re-embed efficiency 'in theory' must mean that the circumstances in the theory are also replicable in practice, or what is being theorised is merely fantasy. As I go on to argue, the theory *does* still ignore some important structural features of the process of mitigation, which implies problems with the theory behind, and not just practice of, carbon trading.

[71] See e.g. Brown, 2002, p185. Whilst Brown argues that location matters from the perspective of equity, he does not contest it on the basis of ecological effectiveness.

some GHG reduction measures also involve a reduction of some non-GHGs and aerosols, which can "indirectly cause significant radiative forcing of climate through chemical processes in the atmosphere"[72]; i.e. associated changes in the balance of other chemicals[73] can produce some warming effects which partly counteract GHG reduction. This means that, because of differences in climate and atmospheric make-up in different parts of the world, these chemical processes have different impacts in different locations, resulting in "a regional variation in the effectiveness of abatement measures".

Berntsen et al conclude that "it cannot be assumed that identical emission reductions will give equal climate effects if the reductions take place in different regions and if several gases and aerosols are affected"[74], and that in fact, according to their study "reductions in China are most effective", based on "equal emissions reductions in all regions"[75]. This threatens to undermine the trading process, although, as they argue, it also complicates the process of the "initial distribution of emission reductions" between countries, since "the same amount of CO_2 reductions in one country may cause a different *net* change in radiative forcing if several non-CO_2 gases are affected when the atmospheric conditions are different"[76].

Similarly, as noted in chapter 2[77], Lenton has emphasised that "large scale discontinuities" or "factors that threaten to tip elements of Earth's climate system into a different state... are not directly dependent on global average temperature, but on localized warming that alters temperature gradients between regions."[78] These can be "influenced by uneven distribution of anthropogenic aerosols in the atmosphere"[79]. Localised changes in radiative forcing from changes in use of particular warming or cooling agents could also, therefore, influence the passing of particular tipping points in that region which, as well as causing localised harms could in turn create positive feedbacks as part of global climate change.

[72] Berntsen et al, 2006, p378
[73] E.g. a reduction in aerosols, which have a cooling effect when they destroy ozone.
[74] Berntsen et al, 2006, p404.
[75] Berntsen et al, 2006, p406.
[76] Berntsen et al, 2006, p406.
[77] Section 1.1, footnote 13.
[78] Lenton, 2011a, p7.
[79] Both by "cooling" and warming" aerosols, and by "land-use change" amongst other factors. Lenton, 2011b, p456

These points add credence to more general concerns about our ability to commensurate different kinds of GHGs into one measure - CO_2 equivalence (CO_2e)[80]. This measure is based on what Lohmann has termed "equivalences that are scientifically dubious"[81] since different GHGs have different lifetimes and radiative forcing effects. Any equivalence relationships are subject to uncertainty, and trading in emissions permits may result in reductions in *different* combinations of GHGs in another country, and *different* radiative forcing effects. As suggested in chapter 2, this might also be a reason for separate caps on different kinds of emissions, and for specifying particular regional reductions in some GHG emissions in some areas, as Lenton has suggested. Here further research is clearly needed, but it means that carbon trading, which relies on commensurability and equivalence of GHG reduction measures in different areas, can directly undermine ecological effectiveness.

But additionally, there are more widely discussed concerns that the location of emissions can have *indirect* effects on global mitigation and, therefore, ecological effectiveness. This point has been made by Lohmann, who argues that allowing emission reductions to occur predominantly in areas where the cheapest reductions can be made can prevent the "structural change required"[82] to tackle climate change in the long-run. This is, for Lohmann, the problem of "path dependency". Lohmann argues that the reduction of emissions should be considered over time, and questions the assumption "that all emissions cuts are the same in terms of climate history". Rather, "How cuts are made now and who makes them will have an influence on how much can be cut in the future". He argues those industries most likely buy additional permits in the first place will be "companies most locked into fossil fuel use and therefore also the ones where change is most necessary and most urgent". This creates a path dependency because "billions of dollars" can be tied into fossil fuel plants, with lifetimes "measured in decades", so that "once a fossil fuelled plant is up and running, it becomes enormously expensive for it to switch to renewable generation"[83]. This dynamic, as is

[80] I do not here consider the even more controversial idea that carbon "sinks" should be included in carbon trading. See Lang, 2009, who argues that "REDD" (reduced emissions from deforestation and forest degradation - the idea that people "should be rewarded for keeping their forests instead of cutting them down"(p214)), should not be financed through carbon trading.
[81] Lohmann, 2008a, p361
[82] Ibid.
[83] Lohmann, 2008b, p6

emphasised in the Friends of the Earth report on carbon trading, is ignored by the economic theory behind it which focuses on "the sellers of credits, not the buyers"[84].

Whilst Lohmann focuses here on trading between companies, the same will be true of trading between nations - if industrialised countries with fossil-fuel dependent infrastructure attempt to meet emission reduction targets by purchasing permits from poorer nations, they will similarly delay "the type of innovation, long-term investments and broad restructuring that are crucial to speeding the transition away from fossil fuels". These changes cannot easily be made later on at short notice at the point at which larger reductions need to be made. Hence for Lohmann, "carbon markets are not only ineffective but also damaging to solutions that *are* effective, and are steering societies away from the changes that are needed"[85]. Agarwal has argued similarly that "if northern countries rely heavily on flexibility mechanisms, they risk being unprepared for much deeper cuts ultimately required to prevent climate change"[86].

Goulder and Nadreau have objected that this kind of "transition argument" is not convincing, since encouraging the faster development of low-carbon technologies in credit-buying countries would mean "more prolonged reliance on fossil fuels by nations that otherwise would sell more permits"[87]. However, the relevance of path-dependency arguments is that it is often credit-buying countries and industries that have a higher structural dependence on fossil fuels which needs to be broken at an early stage. And, as Lohmann has highlighted, those industries (or nations) who are net permit buyers are not necessarily incentivised, as the theory implies, to develop low-carbon means of operating. Rather, the kinds of cuts which are cheapest to make in order to make initial reductions will tend to involve making existing infrastructure more productively efficient rather than, for example, switching to alternative energy production. However, this similarly undermines the ability of the country or organisation to make even deeper cuts in the future, because it commits it further to a fundamentally high-emitting infrastructure rather than starting to make the structural changes which will ultimately need to be made to achieve these subsequent reductions. So for Lohmann, "Cap and Trade's goal of reaching modest numerical emissions targets cheaply is

[84] Clifton and Cullen, 2009, p23, citing Driesen.
[85] Lohmann, 2008b, p2
[86] Agarwal, 2002, p383
[87] Goulder and Nadreau, 2002, p130

simply not the same as the goal of mitigating global warming, which entails taking immediate steps to break the deeply rooted dependence industrialized societies have on fossil fuels"[88]. Crucially, although "A well-implemented cap and trade system might possibly help make a fossil fuel dependent system a bit more efficient around the edges... it is not an appropriate instrument for incentivising the fresh industrial path that the global warming problem requires"[89].

This suggests that one of the most substantial reforms proposed for carbon trading - to limit the proportion of credits which can be traded each year - may still not be sufficient. If they are limited in such a way which still promotes efficiency as 'cost minimisation' or 'pareto optimality' they necessarily delay the higher-cost investments which need to be made[90]. It is in this vein that Kevin Smith has argued that "carbon trading is designed with the express purpose of providing an opportunity to delay making costly, structural changes towards low-carbon technologies. This isn't a malfunction of the market or an unexpected by-product: this is what the market was designed to do"[9192].

This dynamic in carbon trading similarly risks undermining equity –here too, location matters. For carbon trading seems to fall foul of the "low-hanging fruit"[93] problem that critics have highlighted in the CDM. Under the CDM, richer countries can meet their emissions targets through funding projects in poorer countries outside the area of the cap. Even if such projects do reduce emissions overall[94] the credit for the reduction is awarded to the richer country which funded the project. But when the host country comes to make domestic emission reductions, critics argue that it will find that the "cheapest mitigation options have been used by richer countries", which could "increase developing countries' cost of meeting [future] targets".[95] So much for the CDM; but a similar problem could occur even through carbon

[88] Lohmann, 2008b, p7
[89] Ibid.
[90] I return in section 3.3 to the idea that some very minor allowances for trading might arguably need to be built in as a safety net.
[91] Smith, 2007, p1
[92] Furthermore, Clifton and Cullen highlight the risks of carbon financial derivatives creating an unstable speculative "subprime" bubble like the subprime mortgage crisis. (Clifton and Cullen, 2009, p32-35).
[93] Najam et al, 2003, p225.
[94] And there are significant concerns about the problem of "addionality" , see e.g. Smith, 2007, p3, Lohmann, 2009, p510, Clifton and Cullen 2009, p28
[95] Agarwal, 2002, p139 makes a similar point.

trading under a stricter cap-and-trade system. For if, as noted earlier, poorer countries are initially net permit sellers to richer countries since reductions in the former are cheapest, at the point that it becomes cost effective for richer countries to start meeting their emissions obligations domestically, poorer countries will be left with funding the hardest cuts back home.

But secondly, the location of emissions reductions matters for equity also because of the problem of compensation. Receiving money in exchange for ones equitably predistributed permit for emissions does not necessarily provide equivalent benefit to the activities that have been foregone. Shue argues that permit trading and other least cost measures can only be compatible with equity if, in terms of location of emissions, we are "dealing with matters of comparable significance"[96]. As was recalled towards the end of 1.3, the function of emissions must be borne in mind, and some are more fundamental to well-being than others – "survival" versus "luxury"[97] - largely because of other background inequalities between nations. Shue therefore suggests that permit trading will be compatible with and provide adequate compensation for the loss of emissions space only "if *all* incremental costs for reducing emissions... are to be allocated according to ability to pay" - if "beef-eaters" pay for "better feed grain for the subsistence herds of the poor"[98].

And it is not clear that this is the case. Although under an equitable predistribution of emissions permits any reduction in poorer country emissions to meet industrial country quotas would be financially reimbursed, there is no reason that these costs would compensate for the role of that emitting activity. In part this is because it is unclear that the sale would involve the significant transfers that Meyer had suggested[99](cited earlier), or at least significant *enough*. In fact, Baer et al have raised concerns that power imbalances in the reality of markets are likely to mean that poorer countries do not receive a "handsome profit" for selling permits[100]. And Clifton and Cullen have argued that "carbon trading will never provide the reliable and predictable flows of finance to developing countries that are necessary to truly support well-

[96] Shue, 1993, p56
[97] Shue, 1993, p54-56
[98] Shue, 1993, p56
[99] Meyer, 2000, p20.
[100] Baer et al, 2008, p81

planned sustainable development... because the flows are by their very nature unpredictable, depending as they do on the price of carbon at any given time."[101]. Mitigation might not, therefore, result in the "implementation of low-carbon energy services" which would compensate for the loss of ability to increase emission-creating activity[102]. Such costs would not have to just cover particular emissions reductions projects, but wider infrastructural change to e.g. industries that are designed for and developing according to fossil fuel activity.

But this is also particularly problematic if we relate the equity criterion to the principle of "Capacity" advocated in chapter 3. I argued there that the prioritarian focus on 'basic needs' that Shue favours is inadequate in ignoring the importance of relative inequality. Accommodating "all incremental costs for reducing emissions" in poorer countries would therefore need to ensure that this did not make permanent or lock-in the disparity between "beef eaters" of industrialised nations and "subsistence farmers" of poorer countries. Such inequities would, as Baer et al point out[103], disincentivise and be unfair to poorer countries if wealthy countries are seen to be sustaining high-emitting lifestyles which are permanently inaccessible to them. Brown similarly argues that trading "may lead to an unjust use of the global commons" because "If the United States winds up with much larger rights to use the atmosphere as a sink than other nations, and if carbon fuels remain cheaper than other fuels, trading may lock in place U.S. rights to use much cheaper fuels per capita than many other people world-wide"[104]. In these arguments, the concern is not just that relative global inequalities are not being addressed, but, on the contrary, that they might be being *ensured*[105].

I emphasise this point since these concerns about equity might be considered to be peripheral to the issue of equity in climate change mitigation, and instead relate to wider, pre-existing inequalities. It is in this vein that Daly has attempted to respond to the general criticism of tradeable permits that the rich have an advantage:

[101] Clifton and Cullen, 2009, p36.
[102] Baer et al, 2008, p81
[103] Ibid.
[104] Brown, 2002, p197
[105] I.e. there is a difference between failing to attain an ideal and structurally ensuring that it could never be reached.

> "The rich *always* has an advantage, but does this scheme increase or decrease the preexisting advantage of the rich? It could do either, it all *depends on the initial* distribution of ownership of the new assets and not on the fact that they are *tradeable*"[106].

The concerns that I have raised so far about the sense in which trading of permits could undermine equity might in this light be argued to be going beyond equity in climate mitigation, and rather move towards an attempt to achieve socialism through climate policy. However, as I argued in chapter 3, the point here is not primarily to attempt to solve all problems of global inequality. Rather, it is to tackle global inequalities that relate to fossil-fuel use, and ensure future equitable access to the global atmospheric commons, and, therefore, energy. Here, to recall, "equity" is understood primarily in terms of "capacity", i.e. access that would account for differences in capacity to allow for an equal level of well-being between countries in so far as use of the atmospheric commons is necessary for its attainment. However, the possibility of a distinction between these and wider inequalities is precisely what is in question in the analysis I have been presenting.

The inequalities I refer to are central to the issue of equity in climate change mitigation, because of the threat of lock-in. For, in the context of no overall limit to growth (and no cap on emissions), there is the potential, in theory, for those at the bottom to attain the same level / standard of living as those at the top, at some point. But once emitting activity, currently the basis for economic wealth, has been capped, this potential becomes even more remote. Carbon trading, therefore, could risk locking-in these global inequalities and associated power imbalances, and semi-permanently impoverishing some societies even if emissions permits are equitably predistributed. If this argument points towards a socialist outcome, then it merely highlights the kind of reasons that motivate many socialists and justify radical egalitarianism in the first place. It is, as I have argued elsewhere[107] the reason why anyone concerned with tackling poverty and improving the well-being of the worst off must ultimately adopt an egalitarian position.

[106] Daly, 1997, p53
[107] Read and Makoff, 2008

How far this problem of "lock-in" will in fact occur is, of course, ultimately an empirical question. It is entirely possible that poorer countries could still continue to develop in low-carbon, genuinely sustainable ways despite such initial inequalities. Perhaps, then, this would simply need to be monitored during a carbon trading programme. But it is not clear that such a large-scale, long-term global programme is the kind of thing that could be monitored and rectified retrospectively. And whilst it is *possible* that events would not unfold in this way, a cap-and-trade system risks them, by structurally ingraining an equity loop-hole. The cap-and-trade system was being examined here in so far as it is able to *re-embed* efficiency – for the criterion of efficiency to be guided by, and operate within the limits of equity and ecological effectiveness. But in allowing for the possibility of locking-in widescale global inequity, this model seems inadequate.

Again, as considered in the case of ecological effectiveness, one solution might be thought to be to limit the quantity of emissions permits that are tradeable. However, as suggested before, for such a limitation to be sufficient to prevent richer countries avoiding their comparable mitigation burden and making deep structural change away from fossil-fuel dependent energy systems, it would also thereby need to prevent 'cost minimisation' tactics. Such a minimal trading system, whilst plausible, would then function largely to allow some year-to-year flexibility and adjustments in keeping exactly to the yearly budgeted reductions, *rather* than to promote 'efficiency', in terms of cost-minimisation.

One further possible exception here might be if the equitable pre-distribution of emissions results in negative emissions allowances, as it does under the "Greenhouse Development Rights"(GDRs) framework. That is, if some countries need to make emissions reductions of over 100%, which is impossible to be met domestically. Even reductions approaching 100% would be unachievable if required on too short a timescale[108]. But trading in this scenario is not then a question of efficiency but a pragmatic solution to meeting the demands of equity. It therefore fulfill a different function, and could limit the buying of permits only to those past

[108] Indeed, for these reasons I would question the equity of the GDRs formula as a mechanism for emissions distribution and its particular interpretation of historical responsibility; anything that seems to genuinely require a country to reduce its emissions in a way that threatens to impoverish it (even with the kind of radical transition suggested in chapter 2 section 2.4) undermines equality of well-being. Rather, as I suggest in Makoff, 2011, 'Historical Responsibility' should be understood in the context of 'Capacity".

extremely high levels of domestic reduction (e.g. 80-90%) in countries in such climate 'debt'. Alternatively, the demands could be met not exclusively through the predistribution of emissions rights but through formal agreements pairing countries in climate 'debt' with other countries where an appropriate level of emissions reductions would be funded in combination with stringent domestic reductions[109]. This scenario does not, therefore, impact on the question of whether a cap-and-trade scheme would allow for efficiency to be 're-embedded' in the way described by Daly, Meyer and others.

What I have been suggesting through 2.2 is that the supposed paradigm case for theoretically re-embedding efficiency within ecologically desirable and equitable limits does not succeed. For, such attempts retain the conventional understanding of efficiency in narrow economic terms of cost minimisation and/or pareto efficiency, and simply attempt to narrow the scope in which it can operate. However, retention of this cost dynamic from the reductivist neo-classical economic paradigm continues to be in tension with and risks undermining the other criteria, since the incentives of any such system on a day-to-day basis direct activity according to this goal which functions as the *immediate* aim[110]. In arguing this, which I pursue in 3.1, I go further than both Meyer and Daly who both criticise the dominance of the idea of efficiency but who do not significantly revise the concept itself from the dominant forms of pareto optimality or cost-minimisation/utility maximisation. For example, Daly defines allocation as efficient if it "corresponds to effective demand, that is, the relative preferences of the citizens as weighted by their relative incomes, both taken as given"[111], i.e. an "optimal allocation is one that is efficient in giving people what they want and are able to pay for", driven by "relative prices, which measure marginal, opportunity costs"[112]. Daly does attempt a separate ecological formulation of the concept of general efficiency and efficiency ratios, which I consider in 3.2. However, these are, oddly, in *addition* to his retention of allocative efficiency within the context of 'scale' and 'distribution' via the paradigm case of carbon

[109] This would be my preferred approach, for reasons highlighted in the previous footnote.
[110] This argument bears some similarity to Marx's analysis of the general formula for money as capital; that whereas the driver of transactions in the circulation of commodities (C-M-C) is the usefulness of the commodity, under the circulation of money as capital ('M-C-M'), the transaction is a "wonderful means for making still more money out of money"(p256) and the "driving and motivating force, its determining purpose is... exchange value"(p250) (Marx, 1990). However, there is not space to explore this further here.
[111] Daly, 1997, p159.
[112] Daly, 1997, p222

trading, rather than revising the concept in relation to scale/distribution[113]. These distinct efficiency ratios are, as I examine, a promising revision, although they are less radical an alternative than they might first appear.

3.Redefining efficiency

3.1. What kind of concept is efficiency?

It might be concluded from this discussion that the criterion of efficiency is simply incompatible with equity and ecological effectiveness in this context, and should be abandoned, or a trade-off sought[114]. However, as I suggested at the start of this chapter, the general notion of efficiency in terms of, for example, minimising waste, seems a common-sense aspect of attempts to reduce emissions. Rather, it seems fruitful to contest the narrow economic understanding of efficiency and consider whether a different conception could be more compatible with the other criteria. This is to agree with Schumacher who maintains on efficiency more generally:

> "No one in his senses favours inefficiency. The concept of efficiency, however, has become quite uncannily narrow and exclusive: it relates only to the material side of things and only to profit. If I said: 'This process is efficient because it makes the worker a happy man', I should be accused of talking sentimental nonsense, unless I could demonstrate that the worker's happiness actually led to increased output, better quality output, and above all to more profitable output. What the work does to the worker is not recognised as a decisive criterion of efficiency"[115]

[113] Indeed, it is unclear how they are meant to relate to one another. If he is being internally consistent the thought may be that his efficiency ratios simply *amount* to the scale, distribution, allocation relationship exemplified through carbon trading - minimising cost within the bounds of fairness and appropriate scale.
[114] Another possible alternative to abandoning efficiency might seem to be simply returning to efficiency as a *replacement* for the other criteria, as is advocated in environmental economics (and by some ecological economists, e.g. Costanza: see chapter 1, footnote 132). I.e. that rather than being constrained, efficiency should be instead *expanded* to include all environmental/ecological costs and capture the value of everything. However, see my arguments against this in chapter 1, section 3.2, relating to its inability to adequately capture social and ecological concerns.
[115] Schumacher, 1993b, p165

Several important implications follow from Schumacher's insight, for the kind of concept that efficiency is. I draw these out through this section, since they will aid the consideration of substantive alternative conceptions in 3.2.

Most clearly it contests the prevalent idea that, as I criticised in chapter 1, efficiency is a value-neutral concept, as well as its wider application through CBA as an objective and uncontestable mechanism for evaluating outcomes. As I have suggested, and as Schumacher hints, this "uncannily narrow" economic conception is in fact highly value-laden and selective in its assumptions about the goal of efficiency. Brown highlights how CBA itself relies on (act) utilitarian theories in searching for the maximum overall utility from decisions and, he argues, often "a narrow type of utilitarianism, often referred to as 'preference utilitarianism'" [116] in identifying preferences expressed through financial cost as the mechanism for determining utility. And it also relies on "hidden nonutilitarian assumptions"[117] in deciding what the relevant consequences are, the timescale for assessing them, and how to commensurate different kinds of costs and benefits, as has been criticised throughout this thesis.

If efficiency is indeed normative and value-laden, its formulation is open to contest, and reinterpretation. Given that its value-ladenness is being increasingly recognised, it might seem odd that such a lack of explicit alternative conceptions of economic efficiency have been presented. For there are very few attempts amongst heterodox, in particular green and ecological economists to redefine the term. This has been noted by Jollands who has carried out the only explicit overview of the concept of efficiency and review of its use amongst ecological economists[118]. Jollands considers the "potentially rich concept" of the "efficiency criterion" by looking at how far the "wide range of interpretations"[119] from different disciplines are drawn on by ecological economists writing in the journal *Ecological Economics*. These available interpretations include the relationship between system outputs and inputs in thermodynamics, the distinct economic variants of technical, production and

[116] Brown, 2002, p168
[117] Brown, 2002, p55
[118] Jollands, 2006
[119] Jollands, 2006, p360

allocative efficiency, and the efficiency of biological systems in, for example converting energy into work[120] . Despite this, and ecological economics' recognition of the importance of reintegrating efficiency with other considerations, Jollands finds that "there is a divergence between ecological economic theory and revealed practice when it comes to efficiency"[121]. His analysis revealed that most articles retained a conventional economic interpretation of efficiency, and where other (e.g. energy efficiency) concepts were appealed to these were ordinarily not reintegrated into ecological economics. In particular, he found a "lack of development of a uniquely ecological economic approach to efficiency"[122].

Part of the problem may be a failure to recognise *how* it might be reformulated, and the value-assumptions may seem to be a necessary component of economic efficiency. To question this in the way that Schumacher has, one needs to consider the *structure* of the concept of efficiency. And in this respect it is a different kind of concept to the two other criteria. Le Grand,[123] has argued that efficiency can be understood as a "secondary objective", and suggests an interpretation of efficiency such that it could not be traded off with equity. He offers the following definition: that "An allocation of resources is efficient if it is impossible to move toward the attainment of one social objective without moving away from the attainment of another objective"[124]. Whilst one might be concerned with such a formulation in so far as it implies a view of efficiency as a neutral mechanism to arbitrate between competing objectives, the broad implication he draws is nonetheless helpful. That is, that:

> "efficiency can be defined only in relation to the ability of forms of social and economic organization to attain their primary objectives and that therefore efficiency cannot itself be one of those primary objectives... Efficiency is not an objective in the sense that equity is an objective; rather, it is a secondary objective that only acquires meaning with reference to primary objectives such as equity."[125]

[120] Jollands, 2006, p361-362
[121] Jollands, 2006, p363
[122] Jollands, 2006, p364
[123] This is not to concur with any conclusions Le Grand makes elsewhere with regard to policy implications e.g. for reform in public services (see Wintour, 2005)
[124] Le Grand, 1990, p559
[125] Le Grand, 1990, p560

Stein has offered a similar, somewhat blunter critique of the "cult of efficiency"[126]. Stein argues that efficiency is a means rather than an ends, such that we should always specify "at what"[127] and "for whom"[128] a good or process can be efficient. Once this is recognised, the general "trade-off between efficiency and effectiveness... in our public conversation, is blatantly nonsensical", since "Effectiveness is built into any concept of efficiency"[129]. Any "judgements about effectiveness" in meeting particular social goals "must logically precede any cost-effectiveness". Stein argues similarly regarding the "artificial trade-off between efficiency and equity" where both are presented as ends. For, "Properly stated, equity is the end and efficiency is the means."[130]. It therefore "misuses language", she says, when we talk about mere efficiency alone, defined as "an end in itself" and that "divorced from its larger purpose, it becomes nothing less than a cult"[131].

But this can be taken further. Schumacher, in the passage above, argues that the efficiency of a process will be understood differently if its goal is to maximise productive output from if its goal is also/instead to ensure the happiness or well-being of the workers. This means that what will count as waste will also differ significantly, and relates to what the relevant inputs and outputs/goals are held to be. For example, a wholly profit-motivated company may view its workforce's hourly 10 minute breaks as waste and be driven to reduce them if they result in a larger input (time/money) relative to the output received (good/service produced). However, (setting aside arguments that having breaks might also increase workers' productivity), if another 'output' – or, rather, a goal for the company - is to have a happy and healthy workforce, as well as producing a good/service, then the 10 minute break will not be treated as 'waste', but an important contribution to the well-being of the workers, and highly efficient.

If waste and efficiency are seen in this way as a function of a system's output: input ratio, then what counts as waste or efficiency will depend on what the relevant outputs and inputs are judged to be. Stein's broad redefinition of efficiency is useful here. Efficiency is "understood

[126] Stein, 2002, *The Cult of Efficiency*
[127] Stein, 2002, p 11
[128] Stein, 2002, p72
[129] Stein, 2002, p69-70
[130] Stein, 2002, p72.
[131] Stein, 2002, p3-4.

correctly", she suggests, "as ***the best possible use of scarce resources to achieve a valued end***"[132][133]. This may sound fairly unremarkable. But recognising this implies, I suggest, more than simply a need to limit the operational space of conventional economic forms of "efficiency" as in the Daly-Meyer paradigm case of permit trading. And it implies more than achieving equity and ecological effectiveness at a minimum financial cost. Because, as Schumacher's example highlights, financial costs may not capture what counts as waste for one's objectives, Stein's redefinition implies a need to rethink the content and formulation of efficiency in each particular context – of what both the scarce resources and valued end(s) are. How efficiency is measured will also, therefore, change. The conventional narrow economic understanding of efficiency which rests on the theory of CBA understands efficiency through particular measures of success: predominantly, monetary costs and benefits which are meant to aggregate all other kinds of costs and benefits[134]. And, as I have been suggesting in this chapter, pursuing these standards of success can then be at odds with and displace/supplant those standards of success of the other criteria - equity and ecological effectiveness. So, if efficiency is to be understood as a secondary objective, as a criterion for meeting the other criteria, it needs to be redefined and *measured* in the terms of the primary objectives, rather than being merely limited by them.[135]

It is odd that Meyer does not quite draw this conclusion, if we consider the following passage where he explains his criticism of "ideas of efficiency" in climate policy:

[132] Stein, 2002, p6, my emphasis.

[133] This is something Daly also embraces, and indeed it is one of his key insights, as I explore in section 3.2: that in aiming to maximise growth, economics is 'economising' on the wrong thing. In focusing on "capital and labor productivity", we are "using resources lavishly, in other words, by sacrificing resource productivity" when "resources are the limiting factor in the long run, and therefore they are the very factor whose productivity economic logic says should be maximized." (Daly, 1997, p7). This is important because it emphasises that economies with high GDP and high resource throughput are (and in contrast to conventional economic wisdom) actually *inefficient* with respect to resource use. This is expressed in his "ecological economic efficiency" ratios, which I briefly examine in section 3.2. The problem, as I go on to explain, is that Daly does not follow through the theoretical implications for allocative efficiency.

[134] Even through allocative efficiency in market exchange, each party must financially benefit from the transaction.

[135] I am unclear as to whether Stein has come to a similar conclusion. She does suggest at one point that efficiency "takes on different meanings in different spheres of human activity. The yardstick is relative and rooted in context." (Stein, 2002, p12). However, although throughout the book she emphasises the distinctive judgements and measures of the "valued end" aspect of efficiency, she says less about the cost dimension to efficiency – how the "best possible use of scarce resources" might be conceived in different ways depending on the context, and seems to understand it in terms of financial costs.

> "We fought the economists on two fronts - their ideas about efficiency and their use of global cost-benefit analysis... With efficiency we set out to expose it for what it was, a device for screening real people out of the equation in order to ensure that North South inequity was ignored. The economists expressed efficiency in terms of an 'objective'... ratio, the number of dollars-worth of national income generated for every tonne of fossil fuel burned... [but] this is self-referential. It is the economic system establishing value in its own terms. Efficiency can only be measured in terms of one's own objectives and... [the economists] assumed that generating higher money incomes rather than meeting human needs was the objective of the system. So economics was not 'objective', it was *the* objective. As such it was both means and ends. It masqueraded as knowledge of both where we were and where we were going."[136]

Meyer's primary concern with the conventional criterion of efficiency is that it needs to be recognised as a means to externally determined goals and objectives rather than an end in itself. But he fails to recognise that, even as a means, efficiency might therefore need to be reformulated to enable it to express other values. Whilst he comes very close to saying this, in stating that "Efficiency can only be measured in terms of one's own objectives", the term 'measured' here seems to allude not to the *metric* of efficiency, but to the relativity of cost-effectiveness to other goals. For example, analogously, I might consider a more expensive laptop better 'value for money' than a cheaper one, because although it costs more in absolute financial terms, it performs better. My measure of costs is the same (i.e. financial), but the 'effectiveness' of those costs is relative. In the case of climate policy, what Meyer does not seem to explicitly consider is that recognising efficiency as a means to "meeting human needs" and reducing emissions means that its expression as cost-minimisation also needs to be challenged.

In the context of criteria for a climate mitigation agreement, therefore, efficiency must be seen as a different kind of criterion to those of equity and ecological effectiveness, but one connected to them - in particular, a requirement about the way in which these criteria must be fulfilled that must be expressed in their terms. I next consider whether other approaches to

[136] Meyer, 2000, p43-44

economic efficiency could help to reconceive it as an appropriate secondary objective, along the lines of Stein's broad definition. There are, to return to Jollands' concerns cited earlier, very few alternatives. But amongst them *is* an attempted ecological economic redefinition of efficiency by Daly himself. This might seem difficult to reconcile with his retention of a conventional economic understanding of allocative efficiency which, even if limited in operation by scale and distribution, is still understood in terms of a narrow preference-utilitarianism. Indeed, he praises the market as doing "that one thing very well"[137]. But Daly's "ecological economic" conception of efficiency is not an alternative to *allocative* efficiency - rather it is meant to represent a broader notion, in which allocative efficiency is a contributing factor to overall ecological efficiency. It is, in general "the efficiency with which capital, both natural and man-made, is used to provide life-support and life-enhancing services"[138] - the total efficiency of an economy. However, as I shall explain, his particular reconceptualisation of general efficiency is not without problems, since it seems to supervene over the theoretical concepts of distribution and scale as well as allocation. In this sense it offers a replacement rather than supplement or secondary objective to the other criteria. I first consider Daly's reconception of general "ecological economic" efficiency and then move on to suggest how it might be better and more usefully cast as a secondary objective.

3.2 Ecological and Green Economic Efficiency

Daly promisingly argues that "orthodox growth economics has... paid too little attention to the complex notion of efficiency, and that a proper analysis of this concept might lend support to the steady state view"[139]. Jollands has highlighted how Daly criticises conventional measures of an economy's efficiency for considering only "the efficiency of the fund factors, labor and capital", by using "GNP divided by number of laborers or by the value of the stock of producer's goods"[140]. Daly suggests that the efficiency of the economy is therefore determined by "the flow of throughput" and "depletion", and that "In other words, this notion of efficiency measures the efficiency with which we destroy what is valuable!"[141]. The general

[137] Daly & Cobb, 1990, p59.
[138] Daly, 1997, p83
[139] Daly, 1974, p158
[140] Daly, cited in Jollands, 2006, p365
[141] Daly, cited in Jollands, 2006, p365

idea of efficiency, for Daly, is to measure "the ratio of useful service to costs incurred in rendering that service"[142]. Ones particular concept of efficiency will depend on ones definition of "useful service" and of "costs incurred", and he argues that conventional economics does not have a sufficiently developed understanding of either, or how they relate.

In particular, he argues that the "costs incurred" need to distinguish between "natural capital" ("NK") and "man-made capital" ("MMK"), and consider "the amount of service we sacrifice per unit of natural capital lost as a result of its conversion into man-made capital"[143]. This results, for Daly in a general efficiency ratio:

"MMK services gained
NK services sacrificed"

This breaks down into "four components" of:

1. Service Efficiency	(MMK services gained	
	MMK stock)	X
2. Maintenance Efficiency	(MMK stock	
	throughput)	X
3. Growth Efficiency *	(Throughput	
	NK Stock)	X

(*or, as Jollands has pointed out, originally described as "ecosystem maintenance efficiency"[144])

4. Ecosystem Service Efficiency	(NK Stock
	NK services sacrificed). [145]

I will not examine all of these in any detail here, but it is worth offering a brief summary. The first two ratios have been Daly's main preoccupation. Service efficiency describes the

[142] Daly, 1974, p158
[143] Daly, 1997, p84
[144] Jollands, 2006, p366
[145] Summarised from Daly, 1997, p84

efficiency with which services (or "want satisfaction"[146]) are produced from a particular stock of goods and maintenance efficiency recognises throughput as a cost for the production of this stocks which can be minimised in order to maximise maintenance efficiency. Daly argued that maintenance efficiency has been overlooked by economics which has tended to see this relationship in reverse - as "production efficiency", attempting to maximise "throughput (resource flow)... per unit of stock of capital or per worker"[147]. But this ignores the finite physical limits on throughput which are subject to the limits of "the first and second laws of thermodynamics"[148], and in the longer term depletes available physical stock. This was developed further in later versions of Daly's approach to "ecological economic efficiency", where he explains how the size of the throughput can in turn be determined by the third and fourth efficiency ratios - the dependency of this throughput on the growth rate of "natural capital" and how far other "ecosystem services" are sacrificed by making use of it. Whilst the basic insights are helpful, these last two may be problematic in attempting to commensurate all distinct ecosystem "services" and stock in the way alluded to in chapter 1[149], although I shall not consider this any further here.

The main difficulty is how Daly's reconception of ecological economic efficiency relates to his comments elsewhere about the relationship between scale, distribution and (allocative) efficiency. And here there appear to be several problems. Firstly, his new concept of efficiency depends in part on the conventional economic concept of allocative efficiency, which I raised concerns with in 2.2. Allocative efficiency *contributes* to Daly's ratio of service efficiency - the relationship of want satisfaction/service outputs resulting from a given physical stock - in the conventional way through "the economic efficiency of resource allocation among the different product uses in conformity with individual preferences and ability to pay". Although there are other factors which additionally contribute to service efficiency (one of which is mentioned below), Daly's new concept of efficiency does not, therefore, replace conventional allocative efficiency, but retains it, alongside the potential risks to scale and distribution which I have been highlighting.

[146] Daly, 1974, p158
[147] Daly, 1974, p159
[148] Daly, 1974, p159
[149] Chapter 1, section 3.2

Secondly, distribution and scale seem also to be accommodated into these four efficiency ratios. "Distributive efficiency", as Daly here refers to it, also contributes to service efficiency since he argues that services from "man-made capital stock" are maximised when distribution is more equal (though he stands back from "total egalitarianism") because "total social utility is increased when resources are redistributed from the low marginal utility uses of the rich to the high marginal utility uses of the poor". Whilst it may in a sense seem welcome that Daly clearly considers distribution to be important for determining how efficiently goods/ man-made stock are being used, and his rejection of the "Pareto condition that utility cannot be compared across individuals"[150], it reduces the importance of such distribution to the maximising of utility. This leaves it worryingly open to being traded-off against other determinants of utility rather than as the distinct ends which he argues for elsewhere. It may be argued that Daly intends for distribution *also* to be considered as a distinct ends outside the efficiency ratios which intend to capture aspects of distribution in so far as they impact on efficiency. But in this case it is unclear once again how far they are compatible - how far Daly's reconceptualised concept of efficiency is meant to relate to the goals of distribution, and how they are to be prioritised.

Even more worryingly, it also appears as if scale is totally subsumed under these efficiency ratios. Daly argues that "As NK is converted into MMK... we want at each step to maximise the service from the increment of MMK and to minimize the loss of ecosystem services from the decrement of NK. But at some point... this process of conversion of NK into MMK will itself reach an economic limit, an optimal scale of the economic subsystem beyond which further expansion would increase costs faster than benefits"[151]. But crucially, this optimal scale can be defined within this new set of efficiency measures because it takes into account the impacts of the economic subsystem on the containing ecosystem, such that "This optimal scale is defined by the usual economic criterion of equating marginal costs and benefits"[152]. Daly argues that optimal scale is currently being ignored in how our economies operate because of failure to recognise "Ratio 4, ecological service efficiency"[153] which assumes rising marginal costs. Instead, he argues, we sacrifice ecosystem services in a non-marginal way, because

[150] Daly, 1997, p84
[151] Daly, 1997, p86
[152] Daly, 1997, p86
[153] Daly, ibid.

"there has been no rational ordering... to ensure that the least important ecosystem services are always sacrificed first"[154]. By paying "attention to that dimension of efficiency", Daly argues that this "would make the optimal scale of the human niche more definable"[155] - definable, that is, in terms of efficiency and cost-benefit analysis.

If this is right, then Dalys "ecological economic efficiency" cannot therefore, be understood as a secondary objective, or even a distinct concept or criterion to distribution and scale - rather, it appears to accommodate and re-interpret them. But in this case Daly seems to have come full circle from his initial complaints of the failure to recognise the distinctions between them, and this concept returns to the kinds of problems identified in chapter 1 with environmental economics.[156] I.e. it attempts to commensurate different kinds of costs and benefits, obscuring the differences in kind and the explicit value judgements required, in, for example, determining the 'appropriate' level of "natural capital services" which should be "sacrificed" and how this should be weighed against services "gained" from "man-made capital".

This is not to suggest that there is nothing helpful or important about Daly's development of the concept of ecological economic efficiency, which draws important attention both to the physical limitations to efficiency improvements in an economic system and to the complex range of factors which influence efficiency as it is ordinarily understood, and may help communicate problems of scale to conventional economists. Rather, I suggest that if Daly's general approach to ecological economic efficiency can be reconceptualised as a secondary objective to the other climate policy criteria (relating to the distinct concepts of distribution and scale) then it could be a more useful concept not just in the theory of climate policy but eco-political (or green) economics[157].

Why this should be so is clearer from a very similar approach highlighted by Schumacher, which Daly was no doubt influenced by. Schumacher attempts to develop a Buddhist economic perspective, under which he argues that the aim of economics in evaluating standard of living should be "to obtain the maximum of well-being with the minimum of consumption",

[154] Daly, ibid.
[155] Daly, ibid.
[156] And, as noted in chapter 1, section 3.2, with Constanza's approach. (See e.g. Costanza et al, 1997)
[157] I introduced the idea of an "eco-political economy" in chapter 1, section 0.3.

since “Buddhist economics is the systematic study of how to attain given ends with the minimum means"[158]. Whilst this is not explicitly framed in terms of efficiency it bears considerable similarity to Daly’s overall efficiency concept as the ratio between “MMK services gained” and “NK services sacrificed”. However, there are clear limitations to this concept when seen as the unique aim of economics, rather than as a supplement to other considerations/ as a secondary objective. Because it does not itself specify how low the “minimum” consumption might be, merely the *relationship* between consumption and well-being. This “minimum” could end up being dangerously high even if the overall “ratio” between this and the resulting well-being attained was thereby maximised (in the short-term at least). In other words, it is not clear whether one’s priority is to attain the maximum level of well-being and consume the minimum amount which would be necessary to achieve this, or consume the minimum amount possible and obtain the maximum level of well-being attainable from this level. Schumacher - and Daly’s - general concept of efficiency is still fundamentally relational - put simplistically, a ratio between outputs and inputs - and requires other value judgements to be made in order to guide economic activity.

Furthermore, how should the “maximum” of well-being be measured? And similarly, how should Daly’s “MMK services” be understood?[159] Daly implies that it could be understood along the conventional lines of “want satisfaction”, but as he also points out, where ““services”... serve only relative wants, whose only function is to make one feel superior to his neighbor”[160] this can undermine long-term want satisfaction, since “for example, when one’s neighbors all have status automobiles, the status value is cancelled out, and the stock of bug cars becomes a highly inefficient means of satisfying the absolute want for passenger miles of transportation”[161]. This could be tackled in part by specifying absolute or long-term wants, but as I have argued in chapter one and chapter three,[162] well-being should be conceived of as

[158] Schumacher, 1993a, p177
[159] Jollands also makes this point, Jollands, 2006, p368. I return briefly to Jollands' critique of Daly's approach to efficiency shortly
[160] Daly, 1974, p160
[161] Hirsch makes a similar point in arguing that “'positional competition'... at best yields no net benefit and usually involves additional resource costs, so that positional competition itself is liable to be a negative-sum game” (Hirsch, 1976, p52)
[162] Chapter 1, section 2.2; Chapter 3, section 4.4.

more than just utility or preference-satisfaction. In this case determining increases or decreases in the ratio will require appealing to further evaluative concepts.

This is where such a concept could fully integrate with the criteria of ecological effectiveness and equity, where the latter is understood in terms of equality of (objective) well-being. For the "well-being" which we want to maximise, or "services" from man-made capital which we want to improve can be understood simply in terms of our equity criterion, and an "increase" in these services judged according to how far it both improves and equalises aspects of this objectively-defined well-being across people, communities and nations. And how minimal the consumption should be will be determined by the "ecological effectiveness" criterion, in terms of what is ethically appropriate or ecologically prudent. In other words, t*he efficiency criterion simply defines the relationship between the first two criteria*. I sketch how this could work in 3.3.

And this efficiency relationship or "ratio" need not be thought of in terms of one homogenous scale relating the well-being 'outputs' of the resource use to the quantity of resource/natural capital use 'inputs'. It is multi-dimensional because of the distinct aspects of well-being, (although we may use various proxies), and can and should be understood qualitatively as well as quantitatively. When we talk about improving efficiency as "maximising the efficiency ratio", the language can mislead. Rather, the general Schumacher/Daly "Efficiency" concept as a secondary objective need only imply that we should aim to reach, improve and make more equal our levels of objective well-being as far as we can (this is the "maximising" part) from the resources being used. And, if decent equal levels of objective well-being can be achieved from the level of resource use but it is possible to improve or "widen" the efficiency ratio, then we can further reduce resource use[163]. Such a revised concept, I refer to as "green economic efficiency".

It is worth briefly highlighting some of the points of departure between this approach and Jollands' proposed framework for efficiency as a response to Daly. Some of what I suggest here is to agree with Jollands, who also argues that "using efficiency concepts alone cannot

[163] I would not want to assume a drive for unlimited continuous improvements, as discussed briefly in chapter 3, section 4.5, an understanding of objective well-being must also include an idea of 'enough'/satiety.

help distinguish between sustainable and unsustainable resource allocations" and that it is therefore "important to embed efficiency within broader considerations"[164]. Indeed, Jollands proceeds along not entirely dissimilar lines to my conceptual approach in chapter 1, understanding efficiency as embedded in a social and biophysical contexts, and driven by the particular "analytical purpose" of the system under consideration[165].

However, aside from some conceptual differences, our aims for redefining efficiency also differ. I seek to define an efficiency concept or criterion at a macro-economic level, to judge the efficiency with which resources are used by the whole system, and applied to an international agreement on DACC with regards to a particular resource, emissions space. Whereas Jollands aims to define efficiency more broadly, in terms of an "efficiency sphere" which covers all distinct and particular situations in which efficiency might be appealed to. This is in response to a perceived difficulty in Daly's work for failing to adequately promote "pluralism" and to accommodate all possible efficiency concepts from different disciplines[166]. However, I do not think this supposed lack of pluralism is a problem for Daly. This is firstly because his concept of general ecological economic efficiency aims to describe (ecological economic) efficiency in the operation of the economic system as a whole, rather than formulate a concept that holds for all particular scenarios, such as "the efficiency of a thermal electricity generation plant", as Jollands wishes to accommodate. But secondly, Jollands seems to conflate pluralism with relativism, since his criticism of Daly's lack of pluralism is also that Daly offers a "prescriptive ecological economic definition of efficiency", implying that a prescriptive account is problematic. But Daly's prescriptivism is wholly appropriate; some efficiency concepts are simply irrelevant or morally repugnant and there is no reason why a general ecological economic efficiency concept should accommodate them all[167].

[164] Jollands, 2006, p369
[165] Ibid.
[166] Jollands, 2006, p367
[167] Jollands believes it to be a criterion for ecological economists. But "taking a 'transdisciplinary' and 'pluralistic' approach"(Jollands, 2006, p362) merely involves drawing on a range of ideas from different disciplines, and does not equate to either relativism or total pluralism.

3.3 Applying green economic efficiency as a criterion for climate policy.

The concept of green economic efficiency can, then, be used to redefine the third criterion for an international climate change agreement as well as its broader conception suggested by Daly and Schumacher in assessing the efficiency of a total economy/ economic activity. As suggested in 3.2, this should be seen as defining the relationship between the criteria of ecological effectiveness and equity. The equity criterion as I have interpreted it requires emission permits to be distributed between nations so as to allow an equality in capabilities/ objective well-being, in so far as this relies on emissions space, to be achieved between each nation. But, as discussed in chapter 3,[168] if some nations fulfil particular aspects of well-being - particular capabilities - through higher-emitting activities, they will require more "consumption" of emissions space than other nations and be less efficient in the sense of the Daly-Schumacher concept understood as a secondary objective. The redefined efficiency criterion could therefore require that nations move towards widening the ratio between "well-being" and "consumption" or use of emissions space through infrastructural changes so that they require fewer emissions to achieve the same level of well-being. This would mean either that the total global consumption of emissions space/emissions level could be further decreased, or, if necessary, re-allocated amongst all nations to increase (equal levels of) standards of living/well-being[169].

Does this imply that 'inefficient' countries[170] get punished and any poorer countries who do not attain equitable levels of capabilities/well-being with a more minimal use of emissions space (e.g. because of lack of infrastructure) will end up being impoverished, moving more towards an international emissions distribution determined by efficiency that was ruled out at the start of chapter 3? I suggest not: nations should still have emissions permits distributed such that it is possible to attain an equal level of relevant objective well-being (i.e. according to capacity). Rather, the efficiency criterion would require them, firstly, to do this in ways that

[168] Chapter 3, section 4.5
[169] Although both the precautionary principle and the difficulties in keeping GMT below 2ºC, let alone the 1-1.5ºC that I recommend in chapter 2, will almost certainly dictate the former
[170] Remembering that countries such as China, whilst seemingly 'efficient' in returns to labour, are inefficient with regards to resource throughput; by exporting production (and therefore carbon emissions) there, global resource-use has become less efficient.

currently require the least emissions possible and, secondly. increase the emissions-well-being 'efficiency ratio' over time. The criterion effectively requires countries under an international agreement to embark on the kind of transition outlined in chapter 2 section 2.4, and for international climate policy to show how our societies can move towards an equitable level of objective well-being whilst achieving ecologically effective emissions reductions. An agreement fulfilling the demands of efficiency would have to include particular mechanisms to achieve such a transition. For example, establishing green investment funds for national programmes in achieving structural change, such as public transport and cycling networks, renewable energy and energy grid shifts, building retrofitting to reduce energy use and local food production stimulus packages, or changes to international trade and global finance regulations to support such localisation.

The application of the redefined efficiency criterion which I have sketched here and in 3.2. is not, it should be noted, totally antithetical to cost-minimisation/ cost-effectiveness which played a significant role in conventional approaches to efficiency. Some cost reductions may well be a by-product of improvements in green economic efficiency. But because our economic system counts 'bads' as well as 'goods'[171] as cost-benefits, the reverse is not the case - not all cost reductions also indicate improvements in green economic efficiency. Whilst there is some overlap, therefore, they are not synonymous and the criterion of green economic efficiency that I have sketched is designed to supersede "cost-minimising" efficiency, and the perverse incentives that can accompany it through the dynamics of carbon trading[172].

There may be, however, some concerns about ruling out all kinds of carbon trading altogether. For, it may be argued, whilst a full-scale carbon trading scheme fails to promote conventional economic efficiency within the limits of equity and ecological effectiveness, retaining some limited element of trading might be important for other aspects of green economic efficiency, such as flexibility in adapting to problems. Here, it might be argued, the aim would not be to

[171] GNP measures "illth" - negative capital as well as "wealth" (Daly, 1997, p40), i.e. "Environmental and social catastrophes add to GDP" (Scott-Cato, 2009, p115).

[172] Jollands is broadly right to say (Jollands, 2006, p370) that different efficiency concepts are linked because of the "inescapable connectedness of economic-ecological systems". But my point is that some efficiency concepts better represent the kind of efficiency that is important. So conventional 'cost-effectiveness' will play a role in, and affect green economic efficiency, but only as part of a more meaningful (second-order) definition of efficiency, since some cost reductions may aid green economic efficiency, others may not.

minimise cost as such but to allow for the difficulties in anticipating and planning for particular reductions in any country's domestic emissions and, in the terms of the equity criterion I have advocated, the impact this might have on well-being and standard of living. As I suggested towards the end of section 2.2, I see no reason not to allow some very restricted level of carbon trading between countries, so long as it operates in this way, rather than offering choice or 'flexibility' in the broader sense described by Philibert[173] over when and where emissions reductions occur in the first place. Further research would be required to determine the level of trading to which this would need to be limited in order to prevent it being intentionally used to evade emissions reductions.[174]

If efficiency is to be applied as a normative criterion to an international agreement on climate mitigation, conventional understanding of the concept has to be challenged to ensure that it complements, rather than threatens our collective success in averting further DACC. This has not been taken up to date in climate policy literature, and I have offered what I hope will be a helpful contribution towards a better, more appropriate understanding of efficiency that is fit for the task ahead.

[173] Philibert, 2006, p29

[174] An alternative safety net might be instead to allocate emissions permits so that their combined sum is slightly less than the total global budget allocated for the year. However, given that, as argued in chapter 2 section 4, because of difficulty in minimising the likelihood of exceeding GMT rises of 1-1.5°C, let alone 2°C, the total global budget will already need to be set at the lowest level possible to achieve without risk of comparable harms to present generations.

Conclusion.

I began this thesis by advocating that philosophy should play a central role intellectually in tackling DACC by helping to formulate the three key criteria for global climate policy; ecological effectiveness, equity and efficiency. I saw this task as both contriving each criterion and the order in which they are to be applied. Both aspects, I argued, have been underexamined in climate policy literature, and the range of implicit, but questionable interpretations risks them being a blunt instrument to guide policy proposals. Through conceptual and ethical analysis philosophy can help develop justifiable formulations of the criteria, but also help shift the debate by pushing policy advocates to make explicit their assumptions and justify their interpretations. I have offered my own contribution in the thesis.

I framed analysis of the criteria from a green economic perspective in chapter 1. Green Economics, I argued, treats DACC as a global commons problem, but unlike conventional neo-classical economics does not diagnose it game-theoretically, as arising inevitably from the decisions of rational self-interested actors, since there is nothing inevitable about this as a model of human behaviour. Rather, the problem results from societies conforming to the assumptions of the conventional economic model, which it itself reinforces, through failing to recognise the embeddedness of economic activity within social and ecosystemic constraints, and structures which lock in individualistic patterns of economic behaviour. Chapter 1 concluded that the order of the three criteria should reflect this embeddedness through the structural relationship between them, rather than a prioritisation as such. This means that ecological effectiveness, ordered first, must properly determine the constraints for human use of the global atmospheric commons, within which equity, the second criterion can be applied to determine distributive shares. Only then can the third criterion, efficiency, be applied, to guide economic activity within these limits and to support these ends.

Chapter 2 then considered ecological effectiveness as defining the appropriate ecological limits of climate-affecting human activity. In the absence of a clear absolute physical boundary, this involved judging both the harmful effects that should be prevented and how to

morally account for uncertainty over the emissions levels at which these would occur. Regarding the former, I concluded that the criterion required the prevention of any damage to the ecological enabling conditions for the functioning and flourishing of future generations, irrespective of geographical location. These future generations we should not, I argued, regard as simply a temporally disparate group with whom we must share resources fairly over time, but as communities emerging from our own, and for whom we must create the conditions for survival. I argued that such damage had already occurred from current climatic changes, and that preventing GMT rises of 1-1.5ºC seemed more defensible than the widely supported 2ºC, which is associated with more far-reaching damage.

Regarding uncertainty over, in particular, the emission levels that might cause these temperatures, I argued that the kinds of uncertainty and harms at stake called for use of the precautionary principle, as opposed to calculations of the best 'expected utility'. I used the Sandin/Manson general framework for the principle to apply it to DACC. I concluded that, given the severity of harms threatened by DACC under the damage condition, the mitigative action ("e-remedy") taken should be proportional to them, in that "it is the strongest action available which does not pose threats of a comparable or more serious kind to human and wider ecological well-being"[1]. I considered that the kind or degree of uncertainty over the occurrence of such harm is largely irrelevant, so long as the likelihood is non-negligible and the knowledge condition has been met, i.e. there are particular and reasonable grounds to believe that the harm may occur from the activity in question, and because of the nature of that activity. Emissions, therefore, need to be reduced to the level that is most conducive to livable ecological conditions. I concluded that we should aim to reduce emissions concentrations at least to 350ppm CO_2e (net forcing), but seek to reduce emissions of carbon dioxide levels towards pre-industrial level of 280ppm CO_2 as soon as possible over the next few centuries without risking comparable harms from the action taken. This will involve a rapid global socio-economic transition to zero carbon as soon as possible this century, and if possible by 2050[2], where possibility is limited by the need to avoid comparable harms to the conditions for

1 Chapter 2, section 3.4 (iii).

2 Using Ackerman et al's trajectories for achieving 350ppm CO_2 by 2200, Ackerman et al, 2009, p44

well-being of future generations, but widened by the consideration of different socio-economic models.

Chapter 3 considered distributional equity in the shared use of this heavily contracting global emissions space, and the implications for each country's emissions limits. I concluded that, understood within a resource-sharing rather than burden-sharing framework, Capacity is the appropriate principle of equity for a mitigation agreement. I based this on consideration of objective welfare as the morally relevant equalisandum, to which resource-use (use of emissions space) is only a means. Because general well-being is, within the globalised world, currently economically dependent on emitting activity, and countries have varying capacities to move away from this dependence, an equal per capita emissions entitlement may prevent some countries from attaining equal standards of living to others. Capacity then requires distributing the remaining emissions space such that it allows/is sufficient for each country to attain a comparably equal level of objective welfare from their entitlements. It would, in this sense, help guide an equitable transition to a zero-carbon world. Implementing this directly and literally would, I suggested, be very complicated, and the criterion should not be seen as requiring total equality of objective well-being (since it is in any case unclear what this would look like). Rather, policy proposals should be assessed and developed with this understanding of equity in mind, i.e. in consideration of the impacts of a particular emissions allocation distribution on equality of objective well-being.

Chapter 4 argued that in order for the efficiency criterion to complement and be embedded within the first two criteria as outlined in chapter 1, the criterion needs to be rethought from its standard interpretation. I considered how the conventional economic understanding of efficiency in the DACC context as 'cost-minimisation' or, relatedly, pareto optimality, places the criterion of efficiency fundamentally in tension with equity and ecological effectiveness, even when its operation is limited by, for example, trading equitably pre-distributed emissions permits under a cap. I suggested revising the criterion by focusing on efficiency as a means rather than an end; as a secondary objective that guides how primary objectives - here, the first two criteria- should be fulfilled. This involves, I argued, defining it in terms of and according

to the metrics of the first two criteria, rather than exclusively through financial cost. In particular, I concluded that efficiency should define the relationship between equity and ecological effectiveness; as maximising/improving attainment of equal levels of objective well-being from the resources - emissions space - used. Thus a DACC policy is efficient when it either enables more equitable levels of objective well-being (or better levels of equitable well-being) to be attained from given emissions levels, or it enables even lower emissions levels to be attained whilst ensuring equitable levels of objective well-being are not compromised: not simply when financial costs are lower. The criterion therefore requires that an agreement should seek to make human use of the global atmospheric commons more "efficient" in these terms.

Overall, and in brief, I have therefore argued that the three criteria for an international agreement on DACC require that it:

- Aims to prevent GMT rises of above 1-1.5°C, to reduce atmospheric concentrations to at most 350 CO_2e, and therefore ensures a global zero carbon transition this century
- Distributes this emissions budget between countries (and supplement with other resources sharing, knowledge, support) such that each is in a position to attain/develop equal standards of living from it compared to other countries.
- Makes use of the emissions budget efficient in terms of using the least amount necessary to attain these equal standards of living.

How far existing policy proposals would meet these criteria and how they could be modified, is a further, important, project[3]. Whilst Meyer's "Contraction and Convergence" proposal[4], for example, distributes emissions allowances under a cap which could be set as low as required, it only advocates (a convergence to) EPCAs, and does not, therefore, consider whether this is sufficient for equity given different countries' capacities. However, whilst the "Greenhouse

3 Some others have made evaluative assessments, although in relation to different sets of criteria and/or interpretations. See e.g. Aldy et al, 2003, Baer and Athanasiou, 2007b, Kraus, 2009. There is not space for a full examination here, but I intend to write such a report next year for the Green House think-tank.
4 Meyer, 2000

Development Rights" framework proposed by Baer et al[5] attempts to do exactly that, it is enormously more complex and allocates allowances according to both countries' historical responsibility and capacity *combined*, whereas I have suggested that the former is only egalitarian in so far as it correlates to the latter[6]. And both propose emissions trading, to different degrees[7], which I have extensively argued against, with no direct consideration of what I have termed 'green economic efficiency'; ensuring countries use the least emissions necessary for equal objective welfare/standards of living. There may be potential modifications of both frameworks. The "Cap and Share" proposal, for example, which is a variant of Contraction and Convergence[8], suggests a "Transition Fund"[9] for capital projects in countries who prove that their citizens are "more seriously disadvantaged by emissions restrictions". Kyoto2[10], similarly, envisages a global climate fund with "an emphasis on addressing the needs of the poor" in both adaptation and supporting mitigation. However, funds are raised through upstream auctioning to companies, and since companies in different parts of the world will have different capacities to bid for permits; this could affect regional accessibility of services that are currently dependent on emitting activity e.g. provision of energy, in an inequitable way.

Such proposals need to be examined and evaluated with regards to a conceptually and ethically thorough understanding of ecological effectiveness, equity and (green economic) efficiency. With NGOs and campaigners increasingly highlighting the failings in current climate negotiations, academics must contribute to the task of evaluating and developing justifiable policy proposals, to help guide and shift political debate. This must also include the IPCC, which needs to start reviewing and drawing on the kind of philosophical concerns that I

5 Baer et al, 2008

6 Chapter 3, Conclusion; Makoff, 2011

7 Baer et al do express hesitancy about them, and question whether "in principle, alternatives based on taxes, public funds, and other financing mechanisms" would be preferable.

8 It assumes immediate (rather than converging to) EPCAs; these are not allocated to countries. Rather, "pollution authorisation permits" are distributed to every adult in the world, who sell them, via banks or post-offices to fossil fuel producing companies to cover their output, and limit emissions at source ("upstream"). Feasta, 2008.

9 Feasta, 2008, p15

10 See http://www.kyoto2.org/ designed by Oliver Tickell.

have considered and built on here. Tackling DACC of course requires action urgently and at all levels. But, as I have shown here, philosophical argument is an important part of this action, in highlighting both its urgency and helping to shape the solutions that we will, I hope, reach.

Appendix 1 – Anthropocentric versus Ecocentric approaches to harm.

The theoretical division between anthropocentric and non-anthropocentric (ecocentric or biocentric)[1] approaches to value may seem to lead to significantly diverse outcomes in terms of the "level of protection from global warming that the world should agree on"[2]. That is, whether only harms to humans are considered to be morally relevant, or whether additionally harms to non-human entities – individuals of other species, whole species, ecosystems or biological processes – also constitute relevant harms in themselves[3]. On the face of it, it may appear that harms to non-human nature are likely to occur at lower temperature rises than to humans. If so, then non-anthropocentric approaches to harm will define an unacceptable GMT rise as lower than anthropocentric approaches, and the mitigation implications will be more radical.

However, I do not think this is in fact the case, because anthropocentric and non-anthropocentric positions can amount to very similar positions once their distinguishing features are examined more thoroughly. Firstly, they need not disagree on a meta-ethical level, as O'Neill has pointed out[4]. Claims that non-anthropocentric perspectives value non-human nature intrinsically need not be taken to imply a meta-ethical commitment that the source of value comes *from* nature, as some, such as Pepper[5] have assumed, requiring the human perspective to be relinquished. Rather, claims about the intrinsic value of nature can just be taken to be claims about the object of values, as ethical claims that we value certain objects as ends in themselves. Non-anthropocentrism, therefore, does not have to reject what Dobson has called "weak" anthropocentrism[6], where the process of valuing nature is recognised trivially to come from a human perspective.[7] Weak anthropocentrism is, for Dobson, trivially true; "an unavoidable feature of the human condition"[8]. Rather, it primarily rejects what Dobson terms "strong anthropocentrism" – where nature is

[1] Brown defines "biocentric" approaches as valuing all living beings, and "ecocentric" approaches as valuing ecosystems. Brown, 2002, p231
[2] Brown, 2002, p62
[3] I use the term "non-human nature" to refer to parts of nature which are non-human in the biological sense, rather than to refer to parts of nature untouched by or uninfluenced by humans. I also use this term, rather than "nature" or the "environment" precisely because we are a part of 'nature' –it does not lie around us, but encompasses us.
[4] O'Neill 1993, p11
[5] Pepper 1993, p222.
[6] Dobson 2000, p51
[7] See on this Read's argument in Chapter 1 of Read, 2007.
[8] Ibid.

instrumentally valued only in terms of its usefulness to humans[9]. (Though see below for reasons to believe that even strong anthropocentrism, *if* sensitive to the ecological dependence of humans, will in practice not diverge significantly from non-anthropocentrism.)

Secondly, non-anthropocentric approaches to the value of non-human nature (understood henceforth in the "strong" sense) need not be understood in terms of being exclusively on the "intrinsic" side of the "intrinsic"-"instrumental" debate which has problematically been thrashed out in environmental philosophy. Arguments for the "intrinsic" value of non-human nature can seem a reasonable response to strong anthropocentric ethical positions which conceive of non-human nature as only valuable in so far as it is useful to humans, which alone are valuable in themselves, or intrinsically valuable. But since the concept of intrinsic value tends to be grounded in the idea of humans as sentient beings with an interest in their own futures, extending this to the non-human domain is somewhat problematic for anything other than sentient beings (the latter extension which Singer has famously argued for[10]).

However, non-anthropocentric approaches to value can be understood in terms of rejecting the intrinsic-instrumental distinction. Instead, recognising the value of non-human nature can be understood as a respect and admiration for the distinct modes of being of different species, processes, communities, not dissimilar to some interpretations of aesthetic appreciation[11]. This might *include* the "instrumental" roles of a non-human entity - its function within the ecosystem as a whole such that our interdependence and connectedness with it is recognised and revered - but does not exhaust its value such that it is ultimately reducible to the value of the human(s) which stand in particular relations to it (i.e. of respect, admiration, etc). This is analogous (though not identical) to how the value of, say, one's mother (or father, sibling, or friend) is constituted by the instrumental role she plays *as* one's mother – the way in which she cares for and helps you can contribute to rather than detract from your sense of value and appreciation for her once it is recognised.[12]

[9] However, accepting such weak or metaethical anthropocentrism should not be taken to imply projectivism about values either. Rather, it merely acknowledges that humans are fundamentally, inextricably involved in the valuing process.
[10] Singer, 1982
[11] E.g. James describes Murdoch's "state of absorption" whilst observing a kestrel that she relates, such that "the aesthetic appreciation of the kestrel is, she says, accompanied by a selflessness or humility on her part… which would seem to have ethical implications" (James, 2004, p100)
[12] This does not mean all entities are necessarily equally valuable, and different attributes might be thought to

Anthropocentrists can and do also acknowledge this kind of respect-driven relationship between human and non-human nature. They will want nonetheless to insist that valuing non-human entities in this way is still a form of instrumental value, with intrinsic value lying in the human observers. Pepper, for example, argues that the instrumental value of nature should be understood more broadly than its common narrow economic interpretation, instead using the Marxian concept of "use value"[13]. He then argues that this, "Human 'use' will greatly involve moral, spiritual and aesthetic values"[14]. But this then seems to result in only a very subtle distinction in substance between anthropocentric and non-anthropocentric positions[15].

Thirdly, on an operational level, the distinction does not seem to me to be necessary to decide for assessing moral harm in DACC at the level of international policy, if anthropocentrism is understood within the ecological or green economic conceptual picture discussed in chapter 1. By this I mean that ecocentric views which directly value non-human nature would recommend the same temperature limits in a climate change agreement as an ecologically sensitive anthropocentrism, concerned with the ecological enabling conditions of well-being.

Even if non-human nature is only considered valuable "instrumentally", to humans, our dependence on it for our survival and existence; for food, water, energy, atmosphere, minerals amongst others, means that threats to non-human nature also constitute threats to us. In assessing the potential harms presented by DACC from GMT rises, it is not merely the temperature rise in itself which threatens human lives, nor even the impact of this temperature rise on, for example, agriculture through crop productivity. Climate change (both from temperature rise and increases in emissions concentrations which can cause e.g. ocean acidification[16]) threatens the "resilience of ecosystems"[17] whose effective functioning we depend on in complex and uncertain ways which "ecosystem services"

hold different moral weight – sentience might be particularly relevant in some situations. It just means that all parts of non-human nature are morally *considerable*.

[13] Pepper, 1993, p116

[14] Pepper, 1993, p117

[15] Of course, this does not mean the debate is entirely pointless. Whilst both anthropocentric and non-anthropocentric positions can be stretched to largely accommodate the concerns of the other, one may simply be a better fit for the way in which we already do value non-human nature. And each might be argued to be strategically important for *motivating* stronger environmental consideration (see Dobson, 2000, p59).

[16] Harvey, 2007a, p2-3

[17] IPCC 2007c, *Summary for Policymakers,* section.C

assessments attempt to capture. Hence the IPCC's fourth report considers 4 categories of "ecosystem services"[18]: Some are more obvious, such as "*Provisioning services"* which includes food, medicine and cosmetics, some slightly less so, such as "*Cultural Services,* which satisfy human spiritual and aesthetic appreciation of ecosystems and their components.". However, it is also the *functioning* and *processes* of ecosystems that we rely on; hence also identified are "*Regulating Services...* such as (a) carbon sequestration, (b) climate and water regulation, (c) protection from natural hazards such as floods, avalanches or rock-fall, (d) water and air purification, and (e) disease and pest regulation.". And, at an even broader level, they identify "*Supporting services"* which "provide a basis" for the other three categories, and include "primary and secondary production, and biodiversity, a resource that is increasingly recognised to sustain many of the goods and services that humans enjoy from ecosystems". Whilst the service-based model for these relationships may be criticised[19], what it recognises is the complex interdependencies at play, which means that *all* threats of damage to ecosystems, should accordingly be understood as (at least) indirect threats to humans. And this in turn implies that even strong anthropocentrism collapses in practice into ecocentrism, at least so far as the purposes of this thesis are concerned.

It might be objected that not all damages are *necessarily* damaging to humans. But this is misleading. It is important to emphasise a difference between damage to ecosystems *as* ecosystems, and damage to entities *in* ecosystems. That is, particular species might be harmed, but this does not necessarily affect the functioning of the ecosystem as a whole, or their ability to sustain human life. There is no in principle way to distinguish between when this will be the case. In part this is a question for ecological science. But also, because of the deeply complex relationships between different species and biological processes within ecosystems, continuous alterations to elements of it can have significant repercussions over time. This is the kind of argument made in defence of biological conservation, which is helpful here. Lovejoy argues (highlighted by Sarkar) that although "the loss of a single species out of the millions that exist seems of so little consequence", this is part of a "classic problem in philosophy" whereby although "increments seem so negligible… in aggregate they are highly significant"[20]. This, he suggests, can lead to a

[18] IPCC 2007c, section 4.1.1.
[19] E.g. Scott-Cato, 2009, p7-8. Moreover, there seems something odd about talking for instance about the 'cultural services' yielded by nature.
[20] Lovejoy, cited in Sarkar, 2005 p15-16. The 'classic problem' in question is presumably the sorites.

problem of overshoot (which is described famously by Meadows et al in *Limits to Growth*[21], and which I examine in chapter 1, section 3.1), such that effects from "increments… in singletons, tens or even thousands of species out of millions… may be imperceptible, and may seem even more so when many of the effects are delayed or are impossible to measure… By the time the accumulated effects of many such incremental decisions are perceived, an overshoot problem is at hand"[22].[23] The conclusion is, as Sarkar also submits, that "it is wise policy to assume, as a precautionary principle, that every species matters". Once again, this threatens the ability of even strong anthropocentrism to diverge in practice from ecocentrism.

Likewise, significant harms to ecosystems in general from DACC should also be prevented if we are not to risk overshoot and threaten the conditions they provide for the sustained flourishing and survival of human beings. Of course, this argument also makes use of the idea of precaution, which I consider in section B of chapter 2. But it is not possible to talk exclusively about the harms themselves without considering aspects of uncertainty/risk. They enter at every level, even in terms of how direct harms to humans can impact, because of the potential for humans to adapt to an uncertain degree. There is therefore an 'irreducibly precautionary element' in the concept of ecological enabling conditions (See part B of Chapter 2, for my discussion of the requirements of precaution, and the technical appendix on uncertainty, Appendix 2, below.).

Indeed, it seems plausible that at, some lower levels of DACC, groups might be able to adapt to damage to ecosystems, if that damage has entailed a shift in the functioning of that ecosystem. For example, by growing different crops in so far as their agriculture is impacted. Using the terminology I have set out, they would need to adapt to a different set of ecological enabling conditions, to be 'enabled' in a different way. The question is, however, whether this could be the case, or whether, in the process of such an enormous

[21] Meadows et al, 2005.
[22] Sarkar, 2005, p14-15.
[23] This is distinct from the "rivet" argument for biodiversity conservation which Sarkar argues against. That is, that the loss of each species to planet earth is like the loss of a rivet on a plane, whereby one individual loss "will not make the plane unsafe" but we risk a "slippery slope" whereby "sooner or later, the next rivet will be like the proverbial last straw that breaks the camel's back". This argument lacks force, he argues, since the loss of many species "will not lead to the collapse of an ecological community" – all it implies is that "if there are so-called keystone species… then these species deserve special attention… It only provides an argument for the preservation of keystone species". Although even here, as Sarkar acknowledges, given that we do not know which species (or combinations of species) might function as "keystone species", each should be regarded precautiously.

shift, mass starvation and suffering would occur. In societies whose entire culture and way of life centres around and is adapted to the production of key food sources – rice, or grain – the impact of having to make such wide ranging changes could potentially be massive, in comparison to capitalist societies where the range of foodstuffs is fairly broad because of dependence on imports[24].

It may be replied that such a potentially devastating shift in lifestyle is precisely what is being required of capitalist societies in taking mitigative action – to rapidly shift energy sources and reduce consumption, which would require altering industry, transport patterns, designs of towns and so on, and which may cause some suffering in the process. However, this is precisely because our society is not culturally rooted within our ecosystems and ecosystemic limits. Our economic path is in any case taking us to these limits and thus to the need for a sudden shift, which would be all the more devastating if left to its own devices. The need for large-scale and rapid shifts in lifestyle and socio-economic organisation as mitigative action *now* is rather to pre-empt and prevent the need for wider and far more devastating changes later and elsewhere, which would stand far less chance of a successful transition. The fundamental problem here is still: how do we know what can be adapted to and what cannot? This would require exploration elsewhere, for the thesis is restricted to considering questions of mitigation, rather than of adaptation. But, just as I suggest in Chapter 2 section 3, uncertainty in the face of such severe harms calls for precaution, not a gamble on outcome.

And it should be remembered that we are concerned with a *global* phenomenon, rather than one particular phenomenon in one locality. This damage, from each degree of GM T rise, will have multiple effects on ecosystems as a whole, so we cannot pick and choose the effects that can be adapted to and those which cannot[25]. This is similarly problematic for the concern that there may be some ecosystems harmed at lower levels of DACC that do not affect humans. We might be able to imagine harm resulting from a particular, lower

[24] The point here is not that capitalist societies would be better able to adapt – since we are so heavily dependent on imports, we would be severely affected by changes elsewhere. The point is rather that it may be hard, within our society, to comprehend the scale and difficulty of change needed throughout the entire economic and social structure from alteration in crop choice because most of us now are so distanced from this process.

[25] Although, as I emphasised at the end of 3.3, *in addition* to local changes resulting from global mean temperature rises, there are some greenhouse gases whose uneven distribution can cause local climatic changes that can be harmful (see Lenton (2011). We may, therefore, need to take *additional* and particular precautions against particular greenhouse gases causing localised harms.

temperature rise to an isolated, self-contained ecosystem. Of course, these are often depended on by small and indigenous communities. But even if it appears not to affect human societies, there are still other ecosystems that would also be harmed by that same GMT rise, as can be observed from the "burning embers" diagram[26] and that in the IPCC fourth report[27] that depict the multiple harmful effects at each GMT rise. Some of those harms are surely going to be dangerous to humans. Once again, we find how difficult it is in practice to extricate harms to humans from harms to ecosystems, and thus how difficult it is to drive any wedge (in practice) between anthropocentric and ecocentric approaches.

In the end, this Appendix suggests that it seems difficult to see how anthropocentric and non-anthropocentric positions could end up having different policy outcomes regarding DACC. Harmful impacts to ecosystems should be included when morally relevant harms and limits to GMT rise from DACC are being defined, even under an 'anthroprocentric' approach. And anthropocentric approaches to moral harm will not necessarily imply lower GMT thresholds for acceptable harm from DACC than ecocentric ones[28][29].

[26] Smith et al, 2009.
[27] IPCC, 2007c, *Summary for Policymakers*, section C.15
[28] I use the caveat "necessarily" because anthropocentric approaches which do not consider the distribution of harms amongst humans may end up advocating that harms do not become unacceptable until higher temperatures, because they judge that significant harms to some regions or groups of people are outweighed by benefits to others. However, I have argued that this is ethically unjustified in chapter 2, section 1.3.
[29] But in any case, most ecocentric perspectives which "directly" value nature and frame moral obligations to avoid harms to it are not absolutist about such values or harms. That is, they do not have the status of inalienable rights which cannot be infringed under any circumstance, or even of equal value. In fact, as is often pointed out, most ecocentric philosophers adhere to a "hierarchy" of value, based on equal considerability but not equal outcome . It is therefore not clear that more stringent limits to GMT rise would be recommended even if harms to non-humans were thought to occur at lower temperature rises than harms to humans. Because the harms caused to some humans from some levels of mitigation might be thought as having moral priority over the harm caused to other natural entities from less stringent mitigation levels.

Appendix 2 – Distinguishing uncertainties in Climate Science.

In this technical appendix I outline the different ways of drawing distinctions over uncertainties surrounding DACC from literature on climate change. Although some authors have drawn particular distinctions, there is, surprisingly, no comprehensive overview of the kinds of distinctions that can be made or the different levels at which they operate (which are represented for reference in the diagram in fig.7.)

1. Uncertainties surrounding DACC.

When knowledge about DACC is said to contain uncertainties, it is firstly important to be clear about *where* the uncertainties are held to lie before such claims are used to influence mitigative action, as others[1] have noted. The term 'uncertainties' might refer to a lack of knowledge in any of three domains. The first I term "theoretical uncertainty" over the greenhouse gas theory for DACC, the second I call "social indeterminacy" over the predictability of future phenomena which depend on human choices and the third I refer to as "scientific uncertainty" *within* climate science over the relationships in the causal chain of effects from GHG emission levels to the resulting impacts from DACC.

The first domain of knowledge has probably received the most media attention and most significantly for climate sceptics, refers to scientific disagreement over the greenhouse gas theory – the very basis of science on DACC[2]. It should be remembered, however, that what is disputed by most climate sceptics is not the basic mechanisms involved in the greenhouse effect by which atmospheric GHGs trap light from the sun as heat which are grounded in foundational premises of physics. The dispute and hence theoretical 'uncertainty' is whether anthropogenic GHG emissions can alter or have altered the constitution of the atmosphere sufficiently to provoke significant temperature changes. Malnes notes that although the response to the latter theoretical uncertainty in defence of the greenhouse gas theory is commonly to point to the near consensus in the scientific community on the theory itself, this is somewhat unsatisfactory a response if it is a question of numbers. "Does the fact that the greenhouse theory has the bulk of qualified opinion on its side attest to its trustworthiness?", he asks. Not, Malnes argues, if, like the

[1] E.g. Brown, 2002, p101-103; Meadows et al, 2005, p116
[2] E.g. as noted by Malnes, 2008.

jury theorem, this assumes that "the credibility of an opinion depends straightforwardly on the number of people who vouch for it", and "grounds a presumption to the effect that scientific disputes can be resolved by counting heads"[3]. This is both because "we should not assume too readily that each scientist is more likely to be right than wrong"[4], a premise which is assumed by the jury theorem, and because it "invites rejoinders"[5] which list scientists who do not adhere to the greenhouse theory which lend credibility to those critical of mitigative action.

However, this argument misconstrues the relevance of numbers. This is not simply a question of head-counting opinions. Rather, it is an indicator of consensus within a scientific paradigm; a coherent body of knowledge that guides scientific inquiry, in the Kuhnian sense[6]. Whilst paradigms can shift, this is only in the presence of significant anomalies which cannot be accommodated, and in the presence of an emergent alternative that better explains them. This is not currently the case in climate science. Greenhouse gas theory, therefore, is the best and most rational approximation that has been proposed at this current time, and there is no adequate reason to assume that it is false. Of course, for Malnes in any case, acknowledging this theoretical uncertainty "does not bear on the question whether the danger of anthropogenic climate change exists… The crucial issue… is whether model-based simulations of the climate give enough reason to reckon with a real danger that ought to be averted", and concludes that "they do, although they may well be wrong"[7]. For the purposes of this thesis, therefore, this kind of uncertainty surrounding the correctness of the basic theory is disregarded. Such uncertainty by definition underlies all scientific theory and should not prevent our use of it to inform our actions, or no science-based action would ever be justifiable.

A second domain of knowledge which can be alluded to surrounds the inability to predict both future emissions levels and future adaptation to climatic changes owing to their dependence on human individual and collective choices. However, although often classed by some authors as an area of uncertainty in DACC[8], it is misleading to cast this alongside the scientific uncertainties considered in the third group below or the sources of error

[3] Malnes, 2008, p666
[4] Malnes, 2008, p667
[5] Malnes, 2008, p669
[6] Kuhn, 1996.
[7] Malnes, 2008, p669
[8] E.g. Brown, 2002, p227; Schneider & Kuntz-Duriseti, 2002, p56.

distinguished in 1.2[9]. For, referring to this kind of unpredictability as an "uncertainty" implies the existence of fixed future states as yet unknown which will verify or falsify contemporary descriptions of future scenarios. Or, alternatively, of unknown fixed causal relations between current and future socio-economic states. Whereas, in depending on human choices and decisions, both our future emissions levels and adaptability have the potential to unfold in a variety of different ways which, as highlighted by Dupuy and Grinbaum[10], are in turn influenced by contemporary depictions of the future themselves.

It is unhelpful, therefore, to describe this as an 'uncertainty' of models of DACC. I offer "social indeterminacy" as a preferable term[11]. Unfortunately, however, some models used in climate science and climate policy do treat these indeterminacies as uncertain parameters in an attempt to predict eventual future climatic states, as opposed to focusing on the relationship between particular (given) levels of emissions and the climatic states that would be likely to arise from such levels, *if* they were to occur. This is the case, for example, with the IPCC 'scenarios'[12].

The third domain is perhaps the most significant for the current question of the appropriate emissions level, since it covers scientific uncertainties within greenhouse gas theory and climate science over the functioning of ecological processes which regulate and are affected by the greenhouse effect. I examine these in the next section.

2. Uncertainties in Climate Science

There are scientific uncertainties at various points in the causal chain (See chapter 2 , fig. 5) from emissions to harms from DACC which can be identified, represented in fig.7. The first is the relationship between quantities of GHG emissions and the resulting atmospheric concentration, and has been termed "carbon sensitivity"[13]. That is, it is uncertain how a particular level of emissions over a particular time period will result into an atmospheric concentration of that substance. This depends in part on the properties of the GHG in

[9] As alluded to by Tomassini et al, 2010, third page (no page numbers available), albeit described as "A further uncertainty of entirely different nature".
[10] Dupuy & Grinbaum, 2005, section 3.
[11] Dupuy and Grinbaum use the term "ontological indeterminacy", but I prefer to use "social indeterminacy" since it more specifically reflects the subject matter.
[12] IPCC, 2007a, *Summary for Policymakers*, section 3.
[13] Matthews et al, 2009, p829

question and on absorption rates by sinks such as oceans and forests, whose take-up of, e.g CO_2 will be in turn affected by temperature amongst other factors.

Next, is the renowned uncertainty over "climate sensitivity"[14]. This is " a measure of the climate system response to sustained radiative forcing… the global surface warming following a doubling of GHG concentrations from pre-industrial levels of 280 parts per million by volume (ppmv)." [15]. It in other words defines the relationship between atmospheric concentrations of GHGs and resulting equilibrium global temperature changes, and is subject to significant uncertainty[16].

A further area of uncertainty in the causal chain is regarding the ecological effects of temperature rises on both global and local levels. How, that is, temperature rises (and also rises in atmospheric GHG concentrations, which, as footnoted in chapter 2 section 1.1, can directly impact on ecosystems) translate into climatic phenomena and how this impacts on and alters ecological processes. In particular there is uncertainty over the point at which various tipping points might be crossed; where "components of the Earth system" are pushed "past critical states into qualitatively different modes of operation, implying large-scale impacts on human and ecological systems"[17]. Some, such as thresholds for "Boreal forest dieback"[18] have a "large uncertainty" and "constitute candidates for surprising society"[19].

However, these relationships and uncertainties are even more complicated because of "carbon cycle feedbacks"[20]. The impacts of a given atmospheric concentration on temperature, climate and ecosystems can in turn cause more carbon to be released (e.g ."ice sheet disintegration, vegetation migration, and GHG release from soils, tundra or ocean sediments"[21]). Accordingly, Hansen et al attempted to account for how some of these longer-term feedbacks might impact on climate sensitivity by examining paleoclimate data, and found that equilibrium sensitivity was in fact 6°C[22]. Or, they can impact carbon sinks

[14] Caldeira et al, 2003, p2053.
[15] Anderson et al, 2008, p3715.
[16] Meinshausen, 2006, p266
[17] Lenton et al, 2008, p1786
[18] Lenton et al, 2008, p1791
[19] Lenton et al, 2008, p1792
[20] Anderson et al, 2008, p3715
[21] Hansen et al, 2008, p217
[22] Hansen et al, 2008.

and their "ability to store CO_2"; this could increase because of "carbon fertilisation", but "Rising temperatures increase the rate of decomposition of carbon and hence decrease the storage capacity of the land"[23]. These feedbacks and their size[24] are themselves subject to uncertainty.

As noted in chapter 2, section 4, because of this complexity it has more recently been suggested that a measure directly representing the relationship between cumulative emissions and GMT is preferable to both carbon sensitivity and equilibrium climate sensitivity[25], since it incorporates both *and* carbon-cycle feedbacks and is, perhaps surprisingly, "better constrained"[26] in terms of uncertainties. This metric has been separately proposed as "Cumulative Warming Commitment (CWC) as the peak warming response to a given total injection of CO_2 into the atmosphere"[27], and the "carbon-climate response (CCR)" as "the climate response to anthropogenic carbon dioxide emissions"[28].

3. Methodological sources of climate science uncertainties.

What I have called "areas of uncertainty" in climate science should be further distinguished from what are best referred to as different methodological *sources* of scientific uncertainty. Although stated in various forms and often listed alongside the areas of uncertainty distinguished in sections 1 and 2[29], these are distinct in that they constitute possible reasons that these uncertainties exist. Three main classifications of possible sources of scientific uncertainty and error can be inferred from the literature. These are useful in considering how best to account for and respond to the uncertainties, since they shed light on what is possible to require of scientific knowledge about DACC, and the ways in which factual statements it offers might be uncertain.

The first source of error that has been highlighted by Patt and Dessai is "measurement error"[30] which also seems to correspond to what Dupuy and Grinbaum call "uncertainty in

[23] Anderson et al, 2008, p3715
[24] Ibid.
[25] Matthews et al, 2009, p829
[26] Allen et al, 2009, p1163
[27] Allen et al, 2009, p1165.
[28] Matthews et al, 2009, p829
[29] See e.g. Brown, 2002, p116-117
[30] Patt and Dessai, 2005, p426. Also mentioned by Schneider and Kuntz-Duriseti, 2002, p55

initial data" [31]. This refers straightforwardly to errors in measuring or recording data on current or historic initial conditions, for example on temperature readings or atmospheric concentrations of GHGs or oceanic concentrations of carbon dioxide. The impacts of such errors on the ultimate predictions of models about the systems they represent can be significant, as Patt and Desai have argued:

> "given that the climate system, and the biological and human systems with which it interacts, are complex and in some cases complex adaptive systems, future outcomes are highly sensitive to small changes in current conditions, meaning that with any errors in measuring important data (and there are always errors in measuring important data), it is impossible precisely to predict future system states"[32]

Dupuy and Grinbaum have similarly pointed out that whilst a system might be such that "a small error on the initial data entails a small error on the final result", if "the trajectories ["paths that its development in time can take", according to the laws governing the system] that start at two points that are initially very close diverge and lead the system in two totally different directions… then a small error on the initial data entails a very large uncertainty regarding the final result… the well-known type of behaviour called *deterministic chaos*"[33].

A second source of error is also highlighted by Patt and Dessai, which I will term "model error". This kind of error arises from "incomplete understanding of how all the relevant systems behave" such that "there is always a certain degree of uncertainty as to whether the models used capture the essential structures of the system"[34]. This also includes the kind of error in parameterisation and adequately representing "feedbacks between processes" which is noted by Tomassini et al[35]. As Emanuel has noted[36], dealing with this by "Changing the values of the parameters or the way the various processes are parameterized… can change not only the climate simulated by the model, but the sensitivity of the model's climate to, say, greenhouse gas increases", so can lead to

[31] Dupuy and Grinbaum, 2005, p461.
[32] Patt and Dessai, 2005, p426
[33] Dupuy and Grinbaum, 2005, p461
[34] Patt and Dessai, 2005, p426
[35] Tomassini et al, 2010, second page (no page numbers available)
[36] Cited in Malnes, 2008, p667

significantly different ranges of predictions in the areas of scientific uncertainty highlighted in section 2.

A third source of error which is superficially similar to but distinct from both previous sources of error, can be found in Dupuy and Grinbaum, arising from the "intrinsic character of the complex system"[37]. This is unlike the circumstances of "deterministic chaos". Instead, the system is subject to "rapid change" in the trajectories of the system and "abrupt modification of its parameters". Here too then, it is not (merely) that the current parameters of the system's processes are not known, but that they themselves can suddenly change. Dupuy and Grinbaum note that such "discontinuities in mathematics are called *catastrophes*"[38], although others have referred to them as "monsters"[39] or "climate surprises"[40], which are "rapid nonlinear responses of the climatic system to anthropogenic forcing"[41].

Such a source of error and uncertainty can be further distinguished from the kind instantiated by the first two sources. Dupuy and Grinbaum describe this as an "objective" as opposed to "epistemic" uncertainty, since the uncertainties arise not from a "temporary insufficiency of our knowledge" but from "objective, structural properties of ecosystems"[42]. Patt and Desai similarly distinguish between this "natural stochastic" uncertainty[43] which "relates to the chaotic nature of the climate system" and "epistemic uncertainty" which "originates from incomplete knowledge of processes that influence events"[44].

4. Conceptual categories of uncertainty

The way in which the scope for such errors is represented scientifically normally involves expressing uncertainties in outcomes as probabilities. Patt and Desai describe how estimates of the probability distributions are attained in the case of "measurement error" by running "predictive models multiple times, varying the data within the range of likely

[37] Dupuy and Grinbaum, 2005, p461
[38] Dupuy and Grinbaum, 2005, p461
[39] Lohmann, 2009, p513
[40] Brown, 2002, p94. Schneider and Kuntz-Duriseti, 2002, p58 refer to these as "imaginable surprises".
[41] Schneider and Kuntz-Duriseti, 2002, p58.
[42] Dupuy and Grinbaum, 2005, p462.
[43] Patt and Dessai, 2005, p427
[44] Patt and Dessai, 2005, p426

measurement error"[45], and to account for "model error", "scientists often have degrees of confidence in different models" and "expert elicitation techniques can often represent the confidence estimates from numerous scientists as probability distributions". However, as Patt and Desai point out, these probability distributions are "highly subjective, based on the informed guesswork of the scientists". That is, the probabilities used to quantify the uncertainties are themselves uncertain. Furthermore, whilst Patt and Desai imply that "natural stochastic uncertainty" can, like "measurement error" be "quantified (with limits) using multiple runs of the model with slighly different initial conditions", it is unclear how useful or certain any resulting probability distributions can be, given that the likelihood of a model following any particular path and the description of the path itself may be unknowable because of the presence of "catastrophes" or "monsters".

Uncertainties over outcomes may not, therefore, be confidently or even meaningfully expressible in terms of probabilities. It is for this reason that it is useful to distinguish between conceptual categories of uncertainty that take account of quantifiable and unquantifiable likelihoods of uncertain events. Such a by now well known distinction is that highlighted by Frank Knight, between "risk" and "uncertainty". Here a "risk" defines an uncertain event or outcome whose likelihood can be quantified by assigning a probability, whereas the latter defines an outcome where it is not possible to do so[46]. The distinction has been further built on by Stirling[47] and by O'Riordan et al[48]. They describe a two-by-two matrix of four concepts of "incertitude", which is defined by quantifiability of likelihood and definability of the outcome itself and its magnitude (see figure 7.). This emphasises the two aspects of uncertainty highlighted in the introduction to chapter 2 – the likelihood of an outcome and the features of an outcome itself. Thus the four concepts of "incertitude" for Stirling are:

- "risk", where the probability of an outcome is known and outcome well-defined as a magnitude.
- "uncertainty", "where there is acknowledged to exist no uniquely valid theoretical or empirical basis for the assigning of probabilities"[49] to outcomes, although the outcome itself is well defined.

[45] Patt and Desai, 2005, p426
[46] Noted by Dupuy and Grinbaum, 2005, p460, amongst others.
[47] Stirling, 2001, p78-79
[48] O'Riordan et al, 2001, p24-25
[49] Stirling, 2001, p78.

- "ambiguity", where there is some basis for probabilities, but the outcome is poorly defined.
- "ignorance", where neither the probability of an outcome nor its features are well defined; there is no basis for defining "a complete set of outcomes", which is "an acknowledgement of the possibility of surprises"[50]. (This applies particularly to the third source of errors described in 1.2).

The areas of uncertainty in climate change described in section 1 do not fit neatly into any one category, and for this reason these four concepts of "incertitude" might be argued to be of limited conceptual use seen as strict categories. Because of the variety of processes in the areas of uncertainty being considered, some likelihoods and outcomes are defined more clearly than others, and to different degrees. However, if treated rather as a two-dimensional scale, they are useful in emphasising how far neither probabilities nor outcomes can be sufficiently captured by the "risk" category. As I shall highlight shortly, quantitative probabilities can not always (confidently, or in principle) be assigned, and outcomes often only loosely defined, either because the magnitude is presentable only as a range or because they are simply unknown.

Uncertainties over the ecological and climatic impacts from a particular GMT rise (the third area of scientific uncertainty in section 2) seem to fall most clearly between categories of uncertainty and ignorance. The IPCC report[51] assesses "key vulnerabilities" which would be impacted by different degrees of temperature rises and the associated climatic changes. But it describes these in terms of the broad impact across a temperature range, with a degree of confidence assigned. Neither the impacts nor probabilities are well defined. For instance, when considering effects on plant growth such as crop yields, for a 1-3 degree GMT rise, the potential impact is described as "Productivity decreases for some cereals in low latitudes... Productivity increases for some cereals in mid/high latitudes".[52] For a GMT rise of more than 3 degrees, "Cereal productivity decreases in some mid/high latitude regions". These broad descriptions are assigned low/medium confidence, and the likelihood is not quantified at all.

The impacts are only stateable in terms of general trends because the scale and complexity

[50] Stirling, 2001, p78
[51] IPCC, 2007c, section 19.3.1
[52] IPCC, 2007c, table 19.1.

of the systems being modelled mean the models are vulnerable to all three sources of error. Models have to look at, in the above example, the impacts of additional CO_2 on plant growth, and then at how this might interact with the temperature rises, changes in patterns of precipitation, increased frequency of extreme events, and pest activity[53] often with evidence from very specific studies. Indeed, the IPCC report asserts that the overall effect on crop yields of such a complex set of interactions is therefore "highly uncertain due to many factors, including large discrepancies in GCM predictions of regional precipitation change, poor representation of impacts of extreme events and the assumed strength of CO_2 fertilisation".[54] In particular, it is acknowledged that the summaries of trends tend to describe only the potential impacts of "mean climate change", which ignores "the possibility for negative surprises" (i.e. those which result from errors of the third kind in representing carbon cycle feedbacks)[55]. These have implied, "in some cases, significant negative impacts in key producing regions of developed countries, even before the middle of this century."

Definitions of impacts are therefore very broad and generalised and are not characterised through probabilities. Much of this third area of uncertainty in climate science, therefore, seems most appropriately categorised as between "uncertainty" and "ignorance", depending on how far impacts can be described. [56] However, uncertainties over climate sensitivity, carbon sensitivity and carbon cycle feedbacks are predominantly but problematically described using the language of formal risk, which can be misleading.

For example, uncertainties in "equilibrium climate sensitivity" are expressed through temperature ranges with probabilities assigned. It is defined as "likely" (i.e. at least a 66 % likelihood[57]) that the true sensitivity lies in the range 2- 4.5 degrees and "very likely" (i.e. at least 90 % likelihood[58]) that climate sensitivity "is larger than 1.5°C", and the IPCC state that "For fundamental physical reasons, as well as data limitations, values substantially

[53] IPCC, 2007c, section 5.4.1
[54] IPCC, 2007c, section 5.4.2.2.
[55] IPCC, 2007c, section 5.4.2.1
[56] Although some impacts have probability ranges assigned to describe general trends, and might therefore be characterised as weak ambiguity rather than ignorance. E.g. IPCC, 2007b, section 10.ES.2, on "temperature extremes": "It is *very likely* that heat waves will be more intense, more frequent and longer lasting in a future warmer climate. Cold episodes are projected to decrease significantly in a future warmer climate. Almost everywhere, daily minimum temperatures are projected to increase faster than daily maximum temperatures, leading to a decrease in diurnal temperature range. Decreases in frost days are projected to occur almost everywhere in the middle and high latitudes, with a comparable increase in growing season length."
[57] IPCC, 2007b, section 1.6
[58] Ibid.

higher than 4.5°C still cannot be excluded"[59]. Therefore, despite the language used to describe the sensitivity, the degree of specificity is insufficient to derive a precisely quantified risk. Since these likelihoods are expressible only as probability ranges applied to very broad ranges of GMT rise, a fixed likelihood of a particular climate sensitivity cannot be calculated formally. In addition, these assigned broad probabilities are themselves uncertain. Schneider and Kuntz-Duriseti write, for example, that "A projected range is a quantifiable range of uncertainty situated within a pop-ulation of possible futures that cannot be fully identified (nominated as "know-able" and "unknowable" uncertainties by Morgan et al.).The limits of this total range of uncertainty are unknown but may be estimated subjectively."[60]. In fact, therefore, this area of uncertainty in climate science seems better characterised by the "uncertainty", rather than "risk" category.

Similarly, the IPCC attempt to express uncertainties in climate sensitivity and carbon sensitivity (and what I referred to in section 1 as social indeterminacy, which I have argued is odd considered as an "uncertainty") through ranges of possible warming from a given emissions level and trajectory[61]. For example, in the fourth IPCC report , for scenario B1, where (carbon equivalent) emissions reach 600ppm by 2100, the "likely" range of GMT increase is projected to be between 1.1 to 2.9 degrees by the end of the 21st century[62]. Whereas for higher emissions scenario A1F1, where (carbon equivalent) emissions concentrations reach 1,500ppm by 2100, the "likely" range of GMT increase is projected to be between 2.4 to 6.4 degrees[63]. These uncertainties and temperature ranges are therefore greater for higher emissions levels, because although it is known that in general "an increasingly large fraction of anthropogenic CO_2 would stay airborne in the atmosphere under a warmer climate"[64], there are significant uncertainties about the precise magnitude of carbon cycle feedbacks at higher emissions scenarios and higher temperatures[65] [66].

[59] Indeed, Meinshausen, 2006, includes a range of climate sensitivities up to 10°C (p266) and, as noted earlier, Hansen et al, 2008 have argued that paleoclimate evidence suggests that climate sensitivity may be 6°C

[60] Schneider & Kuntz-Duriseti, 2002, p66

[61] IPCC, 2007b, section 10.ES.1

[62] IPCC, 2007b, *Summary for Policymakers*, *Projections of Future Climate Change*

[63] Ibid.

[64] IPCC, 2007b, section 10.ES

[65] "The greater uncertainty at higher values results in part from uncertainties in the carbon cycle feedbacks", (Ibid, *Mean Temperature*), and "Atmospheric CO_2 concentrations simulated by these coupled climate-carbon cycle models range between 730 and 1,020 ppm by 2100", (Ibid, *Carbon Cycle*).

[66] Although carbon cycle feedback uncertainties have often not been incorporated at all into models of the relationship between emissions levels and atmospheric concentrations. See IPCC, 2007b, *Summary for Policy makers*, p14: "Models used to date do not include uncertainties in climate-carbon cycle feedback nor do they include the full effects of changes in ice sheet flow, because a basis in published literature is lacking."

Aspects of this knowledge could also be categorised as "ignorance" since there are some feedbacks and mechanisms that are not yet known, in terms of either likelihood or outcome; which Schneider and Kuntz-Duriseti have termed "imaginable surprises"[67].

It is crucial to recognise that due both to the broadness of outcomes and likelihoods, these uncertainties in climate science are therefore not wholly characterisable in terms of formal risks[68]. Crucial, because this significantly influences *how* we can take account of them in our decision-making about mitigation targets, as I consider in chapter 2, section 3[69], and points to a substantial limitation of the conventional economic approach to dealing with uncertainty.

[67] Schneider & Kuntz-Duriseti, 2002, p58: "Extreme events that are not truly unexpected are better described as imaginable abrupt events. And for some surprises, although the outcome is unknown, it is possible to identify imaginable conditions for surprise to occur. For example, as the rate of change of CO_2 concentrations is one imaginable condition for surprise, the system would be less rapidly forced if decision makers chose to slow down the rate at which human activities modify the atmosphere. This would lower the likelihood of surprises. To deal with such questions, the policy community needs to understand both the potential for surprises and the difficulty of using current tools such as integrated assessment models (IAMs) to credibly evaluate the probabilities of currently imaginable "surprises," let alone those not currently envisioned.".
[68] As Lohmann has also argued (Lohmann, 2009, p514), which I discuss in chapter 2, section 3.2.
[69] That is not, therefore, to say that they are not useful in considering appropriate responses, as I suggest in chapter 2, section 4.

Fig.7: Distinctions in climate change uncertainty.

Domains of knowledge relevant to DACC. (section 1)

Theoretical uncertainty about greenhouse gas theory

Social indeterminacy over human choices that will be made over future emissions

Scientific uncertainties along the causal chain (section 2)

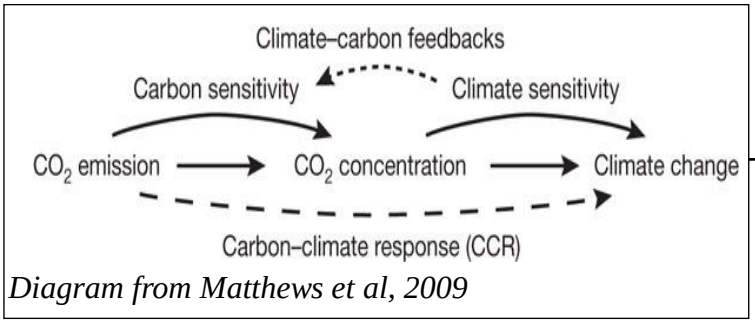

Diagram from Matthews et al, 2009

Ecological impacts

Methodological sources of scientific uncertainties (section 3)

- Measurement/initial data error & deterministic chaos
- Model error & parameterisation
- Nonlinearities/ surprises/ 'monsters'

Conceptual Categories of uncertainty (section 4)

	Outcomes well-defined	*Outcomes poorly defined*
Some basis for probabilities	Risk	Ambiguity
No basis for probabilities	Uncertainty	Ignorance

Based on O'Riordan et al, 2001, p25, fig 1.3

Abbreviations.

CBA	**Cost-benefit analysis**
CDM	**Clean Development Mechanism**
CO_2(e)(ppm)	**Carbon Dioxide (equivalent) (parts per million)**
DACC	**Dangerous Anthropogenic Climate Change**
EPCAs	**Equal Per Capita Allowances**
ETS	**Emissions Trading Scheme**
GMT	**Global Mean Temperature**
GHG(s)	**Greenhouse Gas(es)**
GDRs	**Greenhouse Development Rights**
IPCC	**Intergovernmental Panel on Climate Change**
PP	**Precautionary Principle**
UNFCCC	**United Nations Framework Convention on Climate Change**

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