

HEGEL'S *LOGIC* AND GLOBAL CLIMATE CHANGE

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CHAPTER I

INTRODUCTION

“Nonsense about the absolute. I am generally trying to read Hegel materialistically: Hegel is materialism which has been stood on its head (according to Engels) -- that is to say, I cast aside for the most part God, the Absolute, the Pure Idea, etc.” (Lenin, 1972, 104).

"Hegel's Logic cannot be *applied* in its given form, it cannot be *taken* as given. One *must separate out* from it the logical (epistemological) nuances, after purifying them from *Ideenmystik*" (Lenin, 1972, 226).

My goal in this introduction is to lay the groundwork for my approach to the *Logic*. My approach is inspired by the two quotations above from Lenin. Like Lenin, I want to develop a strategy for reading the *Logic* that is rooted in the fact that one does not accept some of the "mystical" tenets of Hegel's speculative philosophy; although, the strategy goes, we do accept the nuances of the *Logic*, namely Hegel's account of relations, and wish to further develop them. My project is to bring the *Logic*'s exacting account of relations down to earth by bringing it to bear on a natural system of relations, global climate change. To get this project under way, we first need to examine the relation between Hegel's logical categories and things that actually exist. This will take us into Hegel's *Philosophy of Nature*, and the arguments become somewhat complicated. In the final analysis, I hope to show that the categories of the *Science of Logic* are **in** nature in a very specific way. I then apply the *Science of Logic* to global warming, and vice versa.

Logical Categories, Nature, and Materially Existing Individuals

The various approaches to Hegel's *Science of Logic* can be divided into three camps. The first camp is commentators who view the *Logic* as excluding all empirical material, that is, all things that actually exist. Duquette writes that the movement and content of the *Logic* is “thought-thinking-thought, i.e. thought thinking the grounds of its own intelligibility, the Absolute is the grasping of thought by itself in its infinitude...” (Duquette, 1990, 14). Hegel himself seems to support this view: “the system of logic is the realm of shadows, the world of simple essentialities freed from all sensuous concreteness” (Hegel, 1969, 58). This licenses Duquette to write:

It is one of the most common and mistaken views of Hegel's *Logic* that as an ontology it must provide the necessary and sufficient conditions for the existence of anything whatsoever, such as this pen with which I am now writing. But nothing about what actually exists can be deduced from the *Logic*, for as a logic of being, or better of becoming, or better yet of the self-related absolute, it is a logic of structure and significance, not a logic of existence, actual or possible (Duquette, 1990, 16).

Burbidge ascribes the opposite intention to Hegel, then proceeds down a “heretical pathway” that is exactly the same as the one just mapped by Duquette. “Our commentary follows a very heretical pathway,” he writes, “we ignore Hegel's suggestion that the logic is a metaphysics [a logic of existence]. Even though Taylor, Mure, Findlay, and McTaggart all claim that the development of the *Logic* demands reference to ontological and empirical material to justify its transitions, we consider its argument to reflect simply the movement of pure thought” (1981,4). By the same token, according to Klaus Hartmann, a categorial theory such as that of the *Logic* is “devoid of existence claims” (1972, 110). Logical categories “do not pretend knowledge of existences or individual items... There need be no anchorage in existences” (117). On Hartmann's view, logical categories need no anchorage in materially existing individuals (real things) even though

they maintain "the basic program of ordering phenomena [real things] in a systematic fashion" (119).

A more plausible way of stating this view is that the *Logic* deals with relations among its categories without regard to the real embodiment of the categories, or what they are categories of. No one is demanding that what actually exists be *deduced* from the *Logic*, or that the categories of the *Logic* demand "anchorage in existences." The question is how logical categories relate to anything that exists in the first place. If the categories of the *Logic* are not eventually -- maybe not in the *Logic*, and maybe not directly -- categories of anything that exists, then what use is there in examining in such detail the relation among these categories? The British philosopher F.H. Bradley sums up this problem in observing that without some relation to materially existing things the *Logic* is merely "a bloodless ballet of categories" (quoted in Rinaldi, 1992, 304).

The commentators just mentioned by Burbidge, as well as Kaufmann, try to find some middle ground between the *Logic* and empirical phenomena. They are the second camp. Findlay thinks that the transitions between the categories of the *Logic* are "probabilistic" rather than, as Hegel claims, deductively necessary. Taylor holds that Hegel only succeeds in portraying the structure of things as offering 'traces and hints' of his vision of embodied [materialized] spirit" (1975, 231). This approach tries to give the *Logic* some empirical buttressing and leaves it at that. Though I am sympathetic to their efforts, these accounts still leave us in metaphysical limbo.

The third camp includes materialists such as Feuerbach, Marx, Engels, and Lenin. They criticize Hegel for discounting materially existing individuals. They wish to salvage Hegel's categorial account of relations, and apply this account to actual physical

things, while ignoring Hegel's notions of thought-thinking-thought, the pure movement of thought, God, the Idea, the Absolute, or the Concept. My approach to the *Logic* falls in the third camp.

Marx and Feuerbach

The simple version of Marx and Feuerbach's critique of Hegel is that the heroes of Hegel's books are not flesh and blood individuals struggling with suffering, uncertainty, and social and economic forces they cannot hope to master. Rather, Hegel's protagonists are abstract categories of the Absolute Idea. The complicated version of their critique is that Hegel "makes a predicate of its predicate" in privileging logical categories, and Hegel reverses the relation between the real subjects (materially existing things) and logical categories, giving priority to the latter instead of the former. I will deal with these together. It is important to understand the relation between logical categories and things that actually exist because we will return to this time and again.

Hegel thinks that one must (a) begin with an original simple unity, an undeveloped abstract category, (b) descend to its different particular instances, and then (c) ascend back up to a unification of these differences through the category. This is what he calls a "concrete universal." The process is what Hegel calls the unity of the idea, or reflection-into-self. There is a unity among all the different particular instances, and (a) the abstract category is responsible for (b) the development of its different instances and (c) the unity among them. Pretend that the category "cat" is a logical or abstract category. There are different types of cats: lions, tigers, cheetahs, domestic breeds, lynxes, pumas, bobcats, jaguars, and so forth. What makes all these different

creatures cats is that they are types or phenomena of the abstract category “cat.” But such an abstract category, “cat”, is only found **in** real, materially existing lions, tigers, cheetahs, etc. Categories do not have a separate metaphysical status, and they determine the ordering and intelligibility of real things and processes. There is no abstract category without its concrete development. Conversely, there is no concrete development without an abstract category that is logically prior to such development. Real, materially existing cats are predicates of the abstract category “cat,” but at the same time the abstract category “cat” is a predicate of (its predicate) materially existing cats.

Making a predicate of its predicate, then, goes something like this. Hegel claims that the "catness" or all the essential features of materially existing cats is due to their relation to the category "cat." In this sense, materially existing cats are a predicate of the category "cat." But the only way to establish the category "cat" is to look at actual cats. In this sense, the category "cat" is a predicate of actual cats. So the category "cat" is a predicate of real cats and real cats are a predicate of the category "cat", and vice versa. Feuerbach and Marx saw this as viciously circular. To establish the category "cat" Hegel appeals to actual cats. And to establish the "catness" of actual cats, the essential features that make them cats, Hegel appeals to category "cat." Or, if you're head isn't spinning enough already, to establish the "catness" of actual cats Hegel appeals to the category "cat." But to establish the category "cat" Hegel appeals to the "catness" of actual cats.

I've sketched this argument because it highlights two important aspects of Hegel's categories. First, universal categories are found only **in** their manifestations. Second, Hegel is deeply committed to the reality and logical priority of universal

categories. They are what make real processes intelligible. Therefore the following criticism by Marx, from *The Holy Family*, still applies.

If from real apples, pears, strawberries, and almonds I form the general idea [category] "Fruit," if I go further and *imagine* that my abstract idea "Fruit," derived from real fruit, is an entity existing outside me, is indeed the *true* essence of the pear, the apple, etc., then -- in the *language of speculative philosophy* -- I am declaring that "Fruit" is the "Substance" of the pear, the apple, the almond, etc... (for the speculative) philosopher... the different ordinary fruits are different manifestations of the life of "*one* fruit"; they are crystallizations of "*the* Fruit" itself... What is delightful in this speculation is to rediscover all the real fruits there, but fruits which have a higher mystical significance, *which have grown out of the ether of your brain and not out of the material earth* (quoted in Smith 1990, 25, my emphasis).

Marx's criticism is that human beings think up abstract categories and then pretend that materially existing things are determined by them; as if all materially existing cats and fruits were determined by what Althusser rightly dubs the "auto-development" of the respective categories of "cat" and "fruit."

Marxism rejects the theoretical presupposition of the Hegelian model: the presupposition of an original simple unity... [Marxism] rejects, therefore, the Hegelian pretension which accepts this original unity (reproduced at each moment of the process) which will produce the whole complexity of the process later in its auto-development [of the category], but without ever getting lost in this complexity itself without ever losing in it its simplicity or its unity -- since plurality and the complexity will never be more than its own 'phenomenon' (Althusser, 1965, 1998).

I will now try to specify how Hegel's logical categories are, in a limited sense, ontologically real -- that is, at work **in** nature. To do so, we need to examine some Hegelian responses to Marx's criticism and to take of detour through Hegel's philosophy of nature.

Hegelian Responses

Rinaldi replies to the charges that the Idea makes a predicate of its predicate, and that Hegel misunderstands the real subjects. Hegel, as Rinaldi characterizes the objection,

not only would illegitimately transmogrify abstract predicates into concrete, actual subjects (into 'metaphysical monsters'), but would not even hesitate, conversely, to reduce the only true 'real' subjects -- the 'sensuous,' finite 'singulars,' -- to mere predicates of their predicates. In effect, we have seen above that Hegel explicitly denies the concrete actuality of such 'singular' individuals. They are nothing more (nor less) than mere 'phenomena', and do not coincide at all with 'individuality' as moment of the Concept (1992, 296).

The first prong of Rinaldi's reply is that Hegel is not at all concerned with sensuous finite individuals. They merely stand in relation to endless other finite individuals. By contrast, logical individuals stand in relation to the abstract category that determines them.

Suppose that cats are either logical or natural (materially existing) individuals. If cats are only logical individuals then every cat that has existed and will ever exist stands in relation to the category that determines it, not to other cats. If cats are only natural, or materially existing, individuals, each cat stands in relation to all other cats, not to the category "cat." They are, on the latter account, "externally related" because the differences among them are too great to be reconciled under the unity of a logical category. Rinaldi is claiming that, on a much grander scale, although the Idea "contains within itself the moment of existence," no materially existing individuals stand in relation to logical categories.

The idea of the infinite, systematic totality of reality must *necessarily* contain within itself the moment of 'existence,' or rather of *concrete actuality*, as well. For were it a merely unreal, subjective abstraction, it would have 'outside itself' the whole sphere of Objectivity, and thus would in truth be neither 'infinite' nor a totality. The concrete actuality of *pure self-consciousness* and of the *infinite totality*: These, in short, are the two fundamental, irrefutable

evidences of the 'idealistic' principle of the identity of Thought and Being against which all common sense empirical-realistic objections turn out to be ineffectual and vain (305).

Rinaldi's response is dissatisfying. Since natural individuals fall outside "the whole sphere of Objectivity" what exactly does the "moment of existence" entail? According to Rinaldi, the "systematic totality of reality" contains within itself "the moment of existence" or "concrete actuality" even though it does not contain within itself anything that actually exists. Or, alternatively, the "moment of existence" contains all materially existing things but none of them in particular. How can this occur?

Cats could be both natural and logical individuals. They could be logical individuals inasmuch as they share similar irreducible features; this is unity among difference. They could be natural individuals inasmuch as, for example, cats are different sizes, male lions have manes, the saber tooth tiger had saber teeth, some cats have no tails, some meow while others roar, some hunt rodents and birds while others chase antelope and wildebeests, and so forth. These are contingent differences that are insignificant for the category "cat." So some features of every cat are "strongly" determined by the category cat, while other features of cats are simply contingent ("externally juxtaposed") differences bearing little or no relation to the category.

Tony Smith, in his *The Logic of Marx's Capital*, presents a fine-grained approach like this one. He quotes the following passage from the *Philosophy of Spirit*: "This development (Hegel's categorial reconstruction) brings forth a succession of shapes; these, it is true, must be specified empirically, but in the philosophical treatment cannot remain externally juxtaposed, but must be known as the corresponding expression of a series of specific Notions, and they are of interest to philosophy only insofar as they express such a series of Notions" (1990, 12). Smith takes this passage to mean that

"[i]nsofar as the succession of shapes 'must be empirically specified' the content refers to a real process ontologically distinct from the logical process. But insofar as the content expresses 'a necessary series of specific Notions [or categories]' then it simultaneously involves an element that is not given in the real process" (12). I think this interpretation is misguided. The first sentence is correct, but the second sentence involves a misunderstanding.

Smith fails to note that Hegel is here, as in so many other places, denigrating empirical specification. Real processes are "of interest" only insofar as they are related to categories or specific Notions. Otherwise, they are merely "externally juxtaposed," as in the example above with cats. As Rinaldi just observed, a real process (one involving materially existing individuals) ontologically distinct from a logical process is of no concern to Hegel. Thus real processes that do not involve logical processes are inferior to real processes that do, just as empirical specification is inferior to philosophical treatment. When Hegel teases out logical from real processes, he is averring that real processes that bear no relation to specific categories pale in comparison to real processes that do, even in a process that simultaneously involves elements of both. Any element of real processes that is not an expression of a category, any content "that refers to a real process ontologically distinct from a logical process," is *of no interest* to Hegel. In Smith's second sentence, he assuming that categories are independent or separate from what they are categories of; as if "cat" would still have force without materially existing cats: "the content [of a real process] expresses 'a necessary series of specific [categories]'...*that is not given in the real process.*" We have seen that, for Hegel, what Smith is claiming in this sentence is impossible. Categories and real processes mutually

entail one another. Such is the nature of a concrete universal. Categories appear only as given **in** real processes. Logical categories do not have a separate metaphysical status. Therefore the goal of empirical specification of real processes is to come as close as possible to "philosophical treatment" by isolating the extent to which real processes involve logical, or logical-like, processes and categories.

Rinaldi, then, is wrong to hold that Hegel "denies the concrete actuality of singular individuals." He does not deny logical or categorial status to sensuous finite individuals. He is "interested" in them only insofar as they "express" logical categories. Materially existing cats are of interest only insofar as they express the category cat. The contingent differences among cats can merely be empirically specified. This is Hegel's procedure in the *Philosophy of Nature*.

One must not assume that nature is either logically unified or it has no unity at all. Consider a *Zusatz* to the *Encyclopedia Logic*: "In the world of nature it is organic life that corresponds to the grade [*Stufe*] of the notion. Thus the plant e.g. is developed from its germ. The germ virtually involves the whole plant, but does so only ideally or in thought" (1975, 224). Harris writes of this passage that "organic life, in the realm of nature, is what *corresponds to the phases* of the Concept, the process of which is asserted to be development" (Harris, 195, my emphasis). Hegel makes the very same point in the passage above from *The Philosophy of Spirit*. Real processes, insofar as they are subject to philosophical treatment, instead of empirical specification, "must be known as *the corresponding expression* of a necessary series of specific Notions." Not only does nature correspond to the grade or phase of the Concept, nature is also *analogous* to the

concept: “Vegetative life... is a natural analogy of the Concept or subject; it is the Concept externalized in space-time locations” (Hegel, 1959, 184).

Hegel thinks that nature is almost like an idea or logical category, but that does not mean that nature involves full-blown logical self-determination or reflection-into-self. Nature is built up, grade by grade or phase by phase, to something approaching logical determinacy. These layers, however, do not proceed from nature itself. Hegel writes: “Nature is a system of levels (Stufen) where each goes necessarily into a higher one. But the higher is not generated out of the lower. It is the work of the Concept... Metamorphosis proceeds only from the Concept as such, the change of which [of the Concept] is self-development” [*Die Metamorphose kommt nur dem Begriff als solchem zu, da dessen Veranderung allein Entwicklung ist*] (1970, 31). Hegel is further specifying, on the level of materially existing individuals, the point about self-development that Althusser made above. Hegel even analyzes three ways in which plants manifest the Concept, or the reflection-into-self of plants. “The identity of all organs in the metamorphosis of plants is the Concept of their fluid self-differentiation” (Hegel, 1959, 183).

“Organic unity,” as Hegel calls it, is the natural analogue of the unity of logical categories. Logical categories are **in** nature in the diluted form of organic unity. Strictly speaking, logical categories do not *immediately* apply to empirical existents and processes. Logical categories apply to real processes *via* organic unity, which is a less developed form of logical unity. Real processes are expressions of logical categories insofar as such processes are *mediated* by natural categories or organic unity. Natural categories are somehow nested within logical categories (see Halper, 1998).

Marx on the *Logic*

So where does this leave us? It leaves us with us with Hegel's account of categories and their relation to materially existing individuals and real processes -- but without some of the speculative baggage. It leaves us with Marx. I'll now briefly indicate how I am modeling my approach to the *Logic* on Marx's reworking of Hegel.

Marx writes in the "Chapter on Money" of the *Grundrisse* that "in general, relations can be established as existing only by being *thought*, as distinct from the subjects which are in these relations with each other" (1973, 143). As noted in the passage above from Althusser, unlike for Hegel, for Marx abstract categories do not determine or order the complex phenomena of which they are categories. Althusser writes: "a simple category is never original, it only appears as the end result of a long...process" (1965, 197). Marx differs from Hegel in that Marx denies that categories are logically prior to their concrete development. Marx agrees with Hegel that categories are not temporally prior to their development; a category only appears **in** and through its development.

This is the limited sense in which I am claiming that categories are ontologically real. No one can deny that categories such as "labor" and "production" are embodied in myriad empirical specifications, just as no one can deny that 1,190 gigatons of carbon dioxide constitutes the quantity (a logical category) of a certain element in the atmosphere. The categories "labor" and "production" encapsulate pre-existing relations among materially existing individuals just as the category of quantity encapsulates the amount of a certain gas in the atmosphere. So Hegel's categories are at once *in* the complex system of the social, economic, natural, and biochemical relations of global

climate change, and they *give expression* to these relations; relations that, as Marx claims, "can be established as existing only by being *thought* [or given expression], as distinct from the subjects which are *in* [my emphasis] these relations with each other."

An ostensibly mundane example can show how this works. A recent newspaper article reports that a 12-year study suggests that the decline in rice crop yields in the Philippines is due to global warming. Eight of the warmest years ever recorded have been in the last decade. "[A]n average daily temperature increase of 1 degree Celsius resulted in a 10 percent reduction in the rice crop," the article states. The cause of the reduction, researchers speculate, is that "hotter nights make the plants work harder just to maintain themselves, diverting energy from growth" ("Report Suggests Warming Climate Reduces Philippines Rice Crops").

Global warming is a prime example of how a complex system of social, economic, climatic, and biochemical relations affects one of its "real subjects" or materially existing individuals (the rice). The simple, abstract relation of the rice to its environment leads directly to the concrete social and economic milieu of developed and developing nations, their emissions of greenhouse gases, and the complex biochemical impact this has on the ability of the atmosphere to relay heat back into space. Formally expressed, the "simple," "abstract," "immediate" relation of the rice to its environment is "mediated" by a "concrete" or complex web of relations. Given this complexity, we can see why Marx wrote that "relations can be established as existing only by being thought, as distinct from the subjects which are in these relations with each other." The simple relation of the rice to its environment, i.e. the decreased crop yields, can be discerned only through the more complex phenomenon of global warming.

Navigating the *Logic*

To sum up, I plan to bring the *Logic* down to earth and give it “anchorage in existences.” For the beginner or non-specialist, reading the *Logic* can be nothing short of daunting. Perhaps the strangest and most common experience is that one paragraph can be perfectly intelligible, while in the next you have no clue what Hegel is saying. Bearing this in mind, many times I cite and then try to explain the most complex and/or awkwardly phrased passages in order to clarify and demystify them. I hope to demonstrate that the system of relations that brings about global climate change can help us better understand Hegel's *Science of Logic*, while Hegel's *Science of Logic* can help us better understand global climate change.

Let me also take this opportunity to elaborate on the aims and purposes of my project. Admittedly, global climate change and Hegel's *Science of Logic* make strange bedfellows. Climate change is probably the farthest thing from one's mind when one thinks of the *Science of Logic*, and vice-versa. But there is a strong relation between the two. My main goal is elucidate the conceptual structure of the *Science of Logic* by using concrete examples from global climate change. Climate change is particularly appropriate for this task because, like the *Logic*, it is comprised of a system of relations. Indeed, this is the main point of my reading of the *Logic*: something is comprised of how it relates to other things.

Is climate change necessary for understanding the *Logic*? And is the *Logic* necessary for understanding climate change? Of course not. However, climate change is useful for making sense of Hegel's *Logic*, and the *Logic* serves well in helping us better understand global climate change. This is because, again, climate change is comprised of

a system of relations, and the abstract conceptual movement of the *Logic* also gives a rigorous account of how things relate to another. So I use concrete examples from global climate change to ground the more abstract, conceptual movement of the *Logic*.

Having said that, sometimes it is hard to give examples of something that has no examples. The relation between being and nothing at the opening of the *Science of Logic* is a case in point. Throughout Book I, I stick to the general program of climate change. When an example from climate change is not readily available, or not applicable, I use general scientific principles from evolution, the basic forces of physics, and general relativity to illustrate Hegel's points. I do so because I want to show how the relations described in the *Science of Logic* are at work in nature in the special sense in which I have suggested.

In Book II, beginning with essence and up to determinate ground I go through a climate change drought, as it were, though I do discuss the monetary aspects of climate change with regard to the three forms of reflection in essence. The material in these sections is so convoluted that it requires the simplest illustrations possible. So I explain the *Logic* through examples of bread and cookies rather than through socio-economic and environmental processes. I bring climate change back into the picture in determinate ground.

I also discuss different types of global climate change that have occurred in the past. I do not discuss chapter 1 of Section Three, entitled the "Absolute." Nor do I discuss any of Section One of The Doctrine of the Notion. I also omit chapter 2 of section 3, entitled "The Idea of Cognition." All these chapters are just too speculative or mystical for my approach. I realize that by omitting such aspects of the *Logic* I run the

risk of betraying its systematic nature. However, as I just pointed out, I am not reading the *Logic* in the Hegelian sense of a closed system. I am reading it as a sort of treatise on the structure of relations. So ignoring some of Hegel's more speculative ideas should do no harm, while we still retain the essential aspects of *Logic*. I do provide a brief account of the Notion, with specific reference to universal, particular, and individual. We have already, in essence, spelled out the "moments" of the Notion with our cat-example above. I will return to this example quite often.

CHAPTER II

WITH WHAT MUST THE SCIENCE BEGIN

"In no science is the need to begin with the subject matter itself, without preliminary reflections, felt more strongly than in the science of logic" (Hegel, quoted by Maker in Giovanni, 1990, 27).

The preliminary section of the *Science of Logic* only marginally belies the conviction Hegel expresses in the quote above. This section is surprisingly rich in insight and it dovetails nicely some of the points discussed above in the Introduction. Four main items are noteworthy. The first is Hegel's claim that the *Science of Logic* has no presuppositions. Second, the origin of the *Logic* is repeated throughout its entire subsequent development. Third, *everything* contains the logical structure of "immediacy" and "mediation," or reflection-into-self. And fourth, the (immediate) origin, or the logical category, can only be known through its subsequent development (or mediation). We will deal with these items in order.

Much has been made of Hegel's claim that the beginning of the *Logic* "must be *absolute*, or what is synonymous here, an *abstract* beginning; and so it *may not presuppose anything*, must not be mediated by anything nor have a ground; rather it must be itself the ground of the entire science. Consequently, it must be purely and simply *an immediacy...*"(70). By claiming at the outset that the *Logic* is presuppositionless, Hegel does not mean that, as a matter of method, he will not presuppose anything. Quite the contrary, the *Logic* is chock-full of presuppositions. "Posited Reflection," at the

beginning of the "Doctrine of Essence," is perhaps the most marked presupposition. What Hegel means in claiming that the *Logic* does not presuppose anything is that all its presuppositions eventually become constitutive features of the overall internal system of relations in the *Logic*'s course of development. Once a presupposition, something external to the system of relations, has been incorporated into the system of relations, it is no longer a presupposition. It is part of the internal system, which now stands in an external relation to another presupposition, which is then incorporated...and so forth. In the end, the internal system of relations has "swallowed up" all its external presuppositions. The *Logic* has incorporated everything to which it is *externally related*. Therefore the *Science of Logic* is presuppositionless.

Be that as it may, Hegel has just claimed that the beginning of the *Logic* is "immediacy itself" (70). He goes on to claim that "the beginning of philosophy is the foundation which is *present and preserved* [my emphasis] throughout the entire subsequent development, remaining *completely immanent in* [my emphasis] its further determinations" (70). We saw this very idea in action in the first passage from Althusser and with our cat example: the logical form of "cat" (abstract immediacy) is "present and preserved" **in** and *only in* every cat that has or will ever exist (its concrete mediations). In Hegel-speak, this means that the origin is repeated in its immediacy, in its abstract logical purity, even as it is mediated by its subsequent concrete development. It also means that a logical category, if "cat" were one, is *logically prior* to its subsequent development **in** materially existing cats.

Now compare the first and third items. The first is that the origin is "purely and simply *an* immediacy" or "*immediacy* itself." The third is that "there is nothing in heaven

or in nature or in mind or anywhere else which does not contain both immediacy and mediation" (68). If Hegel had an office door, I imagine the latter quote would be posted on it. How can Hegel claim that (1) the beginning is purely and simply immediate and (2) nothing is purely and simply immediate because everything also contains mediation? If this seems contradictory, that is because it is supposed to be. The fourth item of note in the opening section resolves the contradiction.

Hegel writes: "Through this progress [the development of the origin]..the beginning loses the one-sidedness which attaches to it as something simply immediate and abstract; it becomes something mediated, and hence the line of scientific advance becomes a *circle* [from immediacy to mediation and back]. It also follows that *that which forms the beginning is still undeveloped, devoid of content, it is not truly known in the beginning*" (71-72, my emphasis). So (a) there is no origin without its subsequent development; (b) the origin can only be known through its subsequent development; and (c) the origin can never be known *at the origin* or in its purity. Immediacy automatically implies mediation even though both can, in principle, be parsed out. An origin without any subsequent development is not an origin of anything at all. By the same token, something cannot be purely and simply immediate without subsequent mediation.

A simple example can make this intuitive. Suppose King Kamehameha of Hawaii has a son, who subsequently becomes King Kamehameha II. King Kamehameha I is Kamehameha I only because his son became King Kamehameha II. Had his son not become king, King Kamehameha I would be plain old King Kamehameha, without the "I". The point is that there can be no firsts without seconds; no origin without its subsequent development; and no immediacy without mediation. Thus (b) and (c) follow

from (a). An origin can be known only *after* it has begun to develop, only in retrospect, because you don't know that it is an origin of anything until it has subsequently developed. Putting all this together, the significant philosophical point is that even though the logically prior origin is immanently repeated in its abstract purity in its subsequent concrete development (mediation), in what Hegel calls the self-development of logical categories, we can never get a glimpse of the origin in its purity or its immediacy. (1) and (2) from above, then, can peacefully coexist.

With What Does Climate Change Begin?

Hegel's account of the beginning is especially applicable to recent "anthropogenic interference with the climate system," i.e. global warming. The origin of human-induced global warming was, as stated by principle (b), discovered only after it had begun. In Hegel's terms, the origin (abstract immediacy) only revealed itself through its delayed effects (concrete mediation).

So when did global warming begin? Its precise origin is unclear, or in Hegel's terms (c) not known in its purity. Most scientists place the beginning of the Anthropocene era -- the era of human interference with Earth's climate system-- at the beginning of the industrial revolution, around 1750. It has, however, been suggested that "the Anthropocene actually began thousands of years ago as a result of the discovery of agriculture and subsequent technological innovations in the practice of farming" (Ruddiman, 2003, 261; see Figure 5, and Mason, 2004). Whatever the case, the lion's share of CO₂ emissions began in the industrial era, as Figures 1-3, 1-4, and 1-5 make clear.

The discovery of global warming is a detective story more convoluted than the plot to any *film noir*. Oddly enough, it was the Cold War that led to the discovery of global warming. Some dedicated scientists diverted funds earmarked for military use -- such as cloud seeding and study of radioactive fallout -- for their own pet projects, such as measuring CO₂ uptake by the oceans and CO₂ levels in the atmosphere. As the debates and the research continued through the next four decades, and as computer models became more sophisticated, the pieces, one by one, gradually began to fall into place. By the mid 1970's, scientists had figured out that if greenhouse warming had occurred, or was currently taking place, the oceans would delay the warming for a few decades by absorbing the heat in their upper layer. In 1979, one panel of experts explained the effect this way: "We may not be given a warning until the CO₂ level is such that an appreciable climate change is inevitable" (quoted in Weart, 2003, 120). Another panel predicted in 1981 that "considering how fast CO₂ was accumulating, 'carbon dioxide warming should emerge from the noise level of natural climatic variability' by the end of this century'. Other scientists, using different calculations, agreed" (121). The scientists were making a very Hegelian prediction, stating that they will be able to confirm the origin of this phenomenon *only after* it had subsequently developed. In 1981, scientists predicted that the "discovery of global warming -- that is, plain evidence that the greenhouse effect really operated as predicted -- would come around the year 2000" (121).

The first IPCC (International Panel on Climate Change) report, issued in 1990, drew the same conclusion. The report stated that the world had indeed been warming, and that "it would take another decade before scientists could be confident that the

change was caused by the greenhouse effect" (162). As predicted in 1981 and 1990, around 2000 the evidence came pouring in. In IPCC's 2001 report, "the consensus of scientists overwhelmed objections from industry oriented skeptics" and "bluntly concluded the world was getting warmer. And strong new evidence showed that 'most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations' " (187). With the exception of the metaphysical trappings, the origin of the greenhouse effect, its subsequent development, and its discovery followed the same course mapped by Hegel in the opening section of the *Science of Logic*. Figures 1-1 through 1-6 provide some of the evidence for global warming.

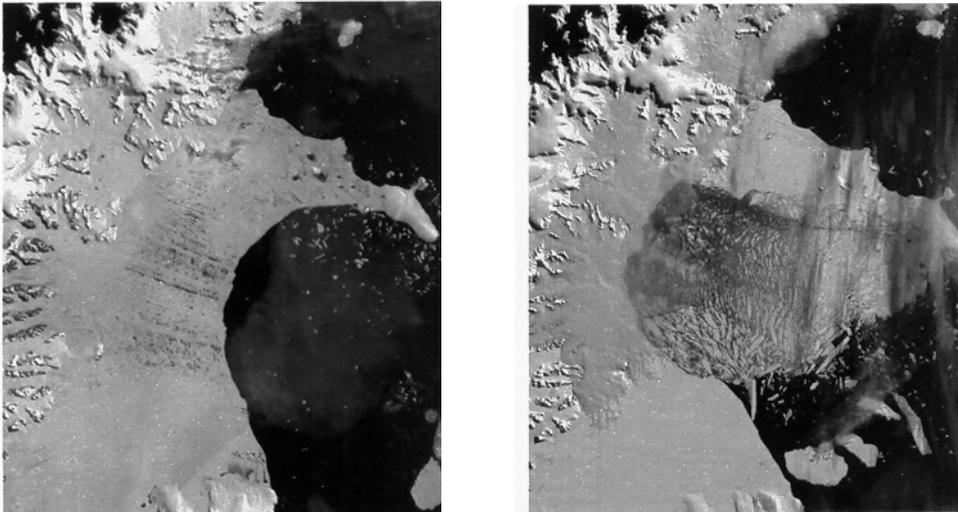


Figure 1-1. The epic collapse of a **1,250** square mile (about the size of Rhode Island) section of the Larsen ice shelf in Antarctica. The collapse took just over a month in early 2002. Melt ponds are visible as dark striations on the floating ice (left) presaging the impending breakup (right). (Reprinted from *National Geographic*, Sept. 2004, 17).

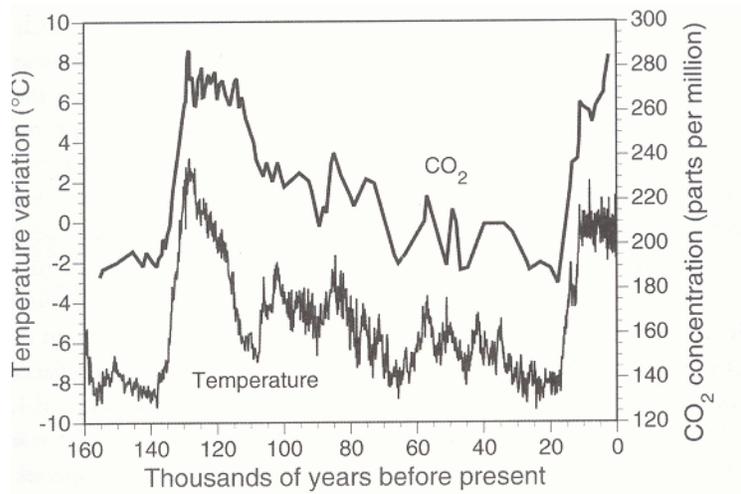


Figure 1-2. Atmospheric carbon dioxide (upper curve) and temperature variation (lower curve) over the past 160,000 years, from ice cores taken at Vostok Antarctica. The record shows long stretches of low temperature (ice ages) separated by brief warm interglacial periods. The correlation between CO₂ and temperature is quite obvious. Note also the small change, averaging perhaps 6°C, between the present warm climate and the recent ice age. Data stops well before the industrial era (see Figure 1-3). (Graph and text reprinted from Wolfson and Schneider, 2002, 15).

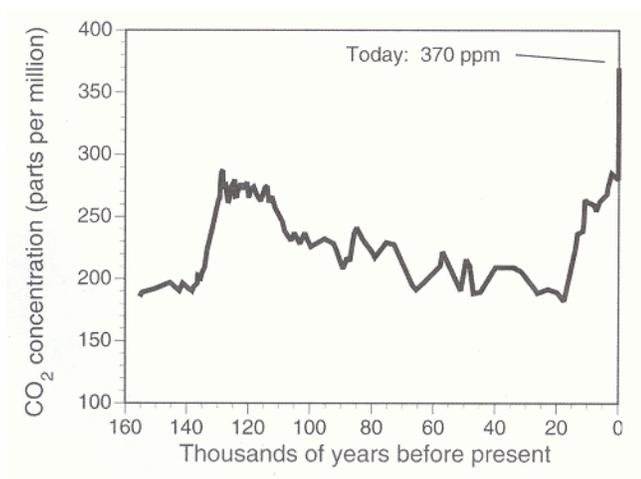


Figure 1-3. The CO₂ record of Figure 1-1, with data to 1999 included. The CO₂ rise shown here is a dramatic jump to levels not seen on Earth for hundreds of thousands (and probably millions) of years. (Graph and text reprinted from Wolfson and Schneider, 2002, 16).

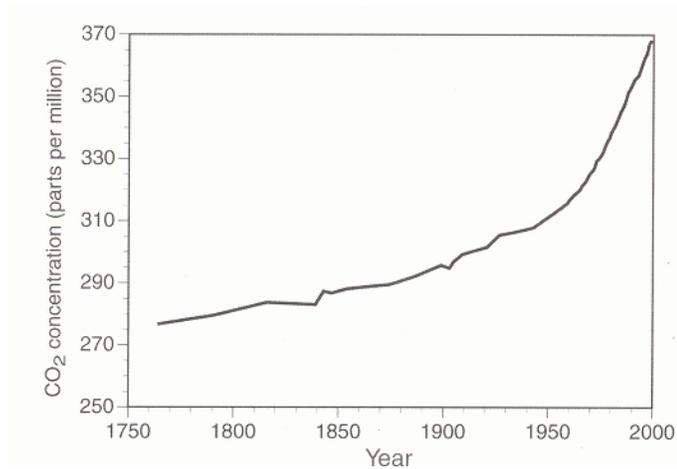


Figure 1-4. Atmospheric carbon dioxide has increased more than 30% since pre-industrial times (Reprinted from Wolfson and Schneider, 2002, 13).

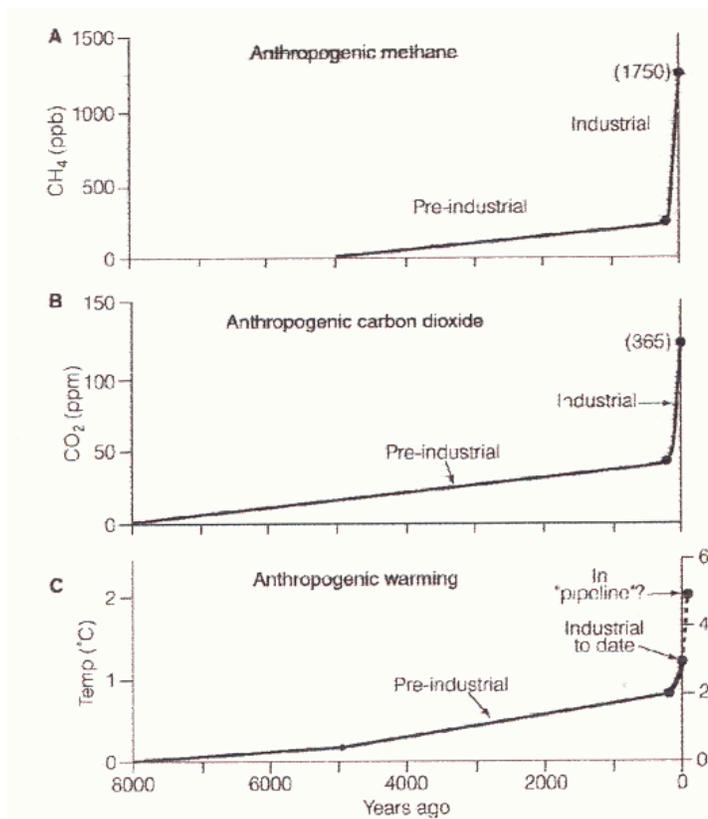


Figure 1-5. The early anthropogenic hypothesis holds that (a,b) pre-industrial and industrial era CH₄ and CO₂ increased from anthropogenic sources. (c) Warming caused by anthropogenic greenhouse gases, global mean temperature scale at left and high latitude temperature on scale at right. In "pipeline" refers to the delayed warming effects of increased CO₂ concentrations in the in the atmosphere. (Reprinted from Ruddiman, 2003, 286).

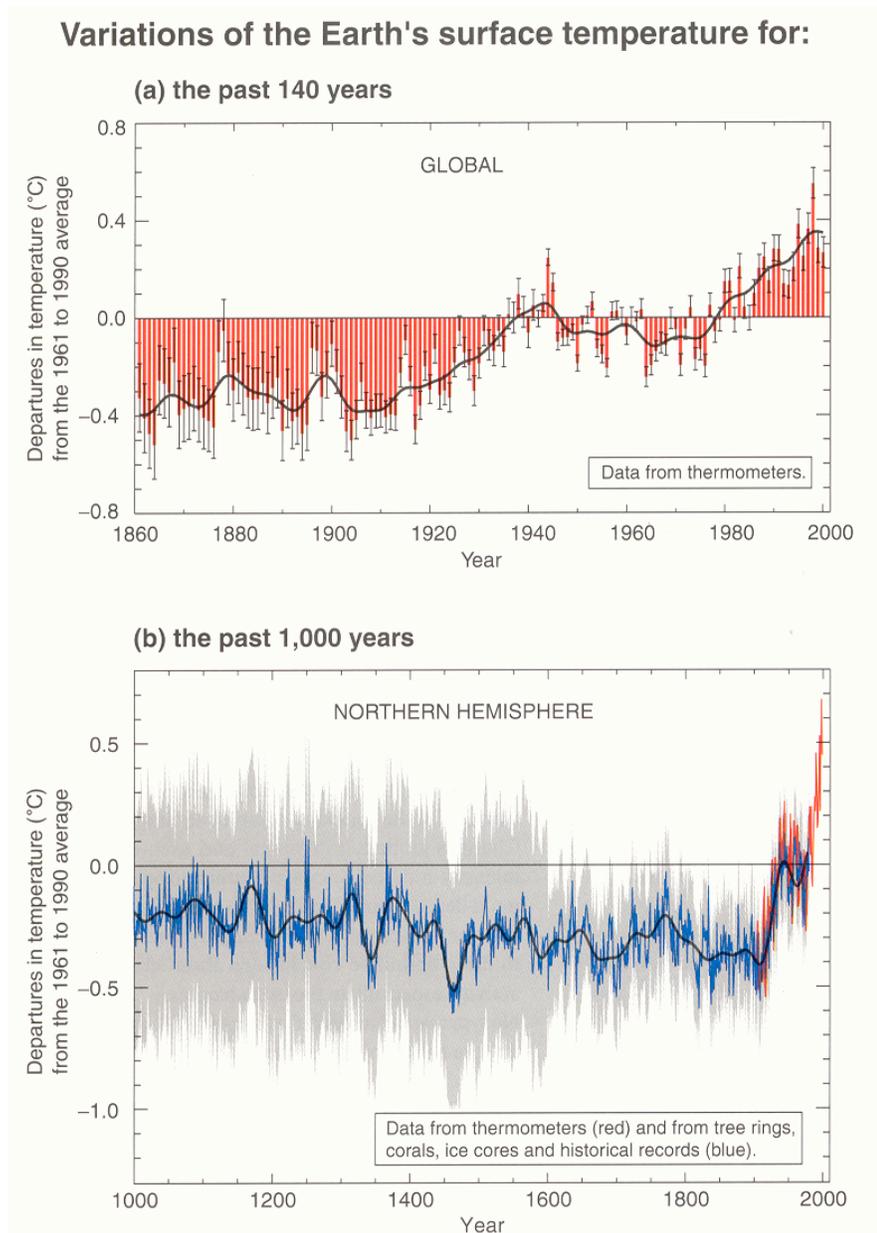


Figure 1-6. (a) The Earth's surface temperature is shown year by year (red bars) and approximately decade by decade (black line, a filtered annual curve suppressing fluctuations below near decadal time scales). There are uncertainties in the annual data (thin black whisker bars represent the 95% confidence range) due to data gaps, random instrumental errors and uncertainties. Over both the last 140 and 100 years, the best estimate is that the global average surface temperature increased by $.6 \pm .2^{\circ}\text{C}$. (b) Additionally, the year by year (blue curve) and 50 year average (black curve) variations of the average surface temperature of the Northern hemisphere for the past 1000 years have been reconstructed from "proxy" data calibrated against thermometer data. The 95% confidence range in the annual data is represented by the grey region. These uncertainties increase in more distant times. Nevertheless, the rate and duration of warming of the 20th century has been much greater than in any of the previous nine centuries. Similarly it is 'likely' (66-90% chance) that the 1990s have been the warmest decade and 1998 the warmest year of the millennium. (Text and graphs reprinted from IPCC, 2001, 153)

CHAPTER III

THE DOCTRINE OF BEING

"It's amazing to me how often Congress, Capitol Hill, and Washington end up becoming evidence-free zones because people do not want to deal with what the evidence demonstrates" (Senator Clinton, in debating the "Climate Stewardship Act of 2003," available at: <http://www.congress.gov>)

"We don't want to be alarmists, but we are alarmed" (Richard Ostfield, speaking of the worrisome accumulation of evidence pointing towards increased incidents of infectious diseases caused by global warming, quoted in Gelbspan, 2004, 121).

Being and Nothing

There is a simple way to experience global warming firsthand and, at the same time, to see Hegel's notions of Being, Nothing, and Becoming in action. On a sunny day, walk outside and look up at the sun; then look down at the ground, preferably at some pavement or concrete off which the light is reflecting; then raise your eyes to the sky, doing a full 360 in order to take in the whole panorama. As shown in Figure 1-7, the energy reflected off Earth's surface and back into space, by clouds, aerosols, ice, snow, desert, etc. is never converted to heat. So this reflected energy plays no significant role in climate. It is the energy that you don't see, infrared radiation, that plays a role in climate. Some solar energy is absorbed in the atmosphere, directly heating it, so it never reaches the surface of Earth. The remainder reaches and warms the surface which, in turn, radiates energy back into the atmosphere. Greenhouse gases such as carbon dioxide (the main culprit), methane, nitrogen oxide, and many others, trap the "outgoing long wave radiation" and shoot it back down to Earth's surface, which then absorbs some heat,

reflects still more into the atmosphere...then repeat the process. Figure 1-7 provides a more detailed explanation.

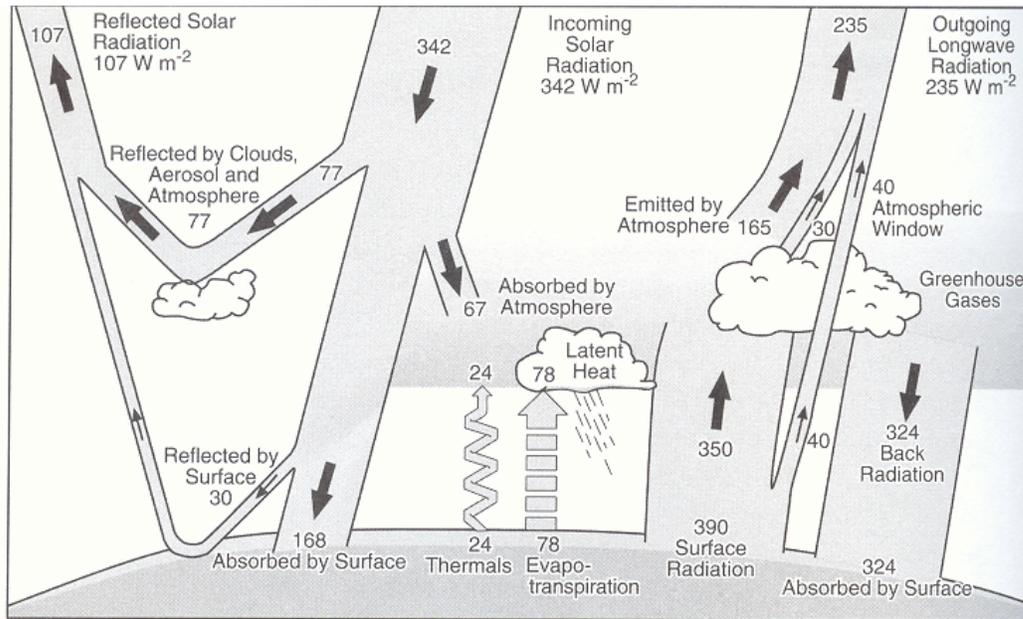


Figure 1-7. (Reprinted from Wolfson and Schneider, 2002, 12).

The total rate at which energy leaves Earth, 107W/m² of reflected sunlight [top left] plus 235 W/m² of infrared (long-wave) radiation [top right] is equal to the incoming 342 W/m² of incident sunlight [top middle]. A "watt" is simply a measure of energy. You can think of the incoming and outgoing 342 W/m² as the same amount of energy as about 3½ 100 watt light bulbs spread across every square meter of the earth's surface. In this scenario, the Earth is in energy balance. Because the Earth is in energy balance, the surface temperature is significantly higher than it would be without greenhouse gases. Surface warming (global warming) is a way in which the Earth maintains its energy balance. This principle was first discovered in 1827 by French scientist Jean Baptiste Fourier: "a planet obtains energy at a certain rate from various sources, and warms up

until it loses heat at the same rate" (Pierrehumbert, 2004, 6777). When infrared radiation that comes into the atmosphere does not escape the atmosphere, because greenhouse gases prevent its escape (shown on the far right), the surface of Earth will literally absorb the difference. Figure 1-7 shows that surface warming is 155 W m^{-2} (390 W m^{-2} surface radiation minus 235 W m^{-2} outgoing longwave radiation). As Fourier first observed, the greenhouse effect is normal. Greenhouse gases amplify the effect.

We have already noted in Figure 1-3 that the present CO₂ concentration of about 368 ppm (parts per million), compared to the pre-industrial concentration of about 280 ppm, "has not been exceeded during the past 420,000 years (the span measurable in ice-cores) and likely not during the past 20 million years. The rate of increase is unprecedented relative to any sustained global changes during the past 20,000 years" (IPCC, 137). Combined with other minor factors, this has produced an average surface warming of $.4\text{-}.6^{\circ}\text{C}$ ($.72\text{-}1.0^{\circ}\text{F}$).

When turning the 360 suggested above, think of the atmosphere as Being, surrounding and permeating us. We breathe it every second; its oxygen fuels our muscles and organs. Yet from our earthbound perspective the atmosphere is nowhere in particular. It sort of amorphously lingers in us and above us. Only from outer space, from the perspective of Figure 1-8, where you are in a position to assess the whole, can you say 'that in particular, at that point, is the earth's atmosphere, and these regions of black are *not* the Earth's atmosphere.' From our earthbound perspective, the atmosphere is nowhere in particular because it is everywhere. Apart from the sun, in daytime you cannot point to a place where it is not there.



Figure 1-8. The Earth's atmosphere is both everywhere and nowhere in particular.

To say that something is everywhere is *not* to be able to say that 'it is here but *not* there.' On the cloudy, snowy day on which I am writing this it is impossible for me to point to a place that is not encompassed by Earth's atmosphere. Not being able to point out, or determine, a 'here but not there,' or just a 'not-there,' is what Hegel calls absence of determination. Both being and nothing, everywhere and nowhere, lack determination. You can't determine a 'not-there' about something that is everywhere because it is everywhere; and you can't determine a 'not-there' about nowhere because there is nowhere to point out. So being and nothing, like everywhere and nowhere, are *identical*

in that they both lack any determination. Let me repeat this point for emphasis: everywhere and nowhere (being and nothing) are identical in that both lack determination. As Hegel puts it, “Nothing is... the same determination, or rather absence of determination, and thus altogether the same as pure *being*” (82). Like everywhere and nowhere, being and nothing are opposites and yet they are exactly the same.

Now that we have the general picture, I want to frame the point more succinctly in Hegelian terms. Indeterminate being can be indeterminate only by distinguishing itself from any or all particular determinations. In the case at hand, not-being-determinate is a determination. As we just saw, being indeterminate is not being able to say ‘not-*x*’ about whatever it is that is indeterminate. But we can say ‘not-*x*’ about indeterminate being; we can say that it is not-determinate. Indeterminate being is the same as not-being-determinate, not-being anything or anywhere in particular. Nothing is obviously no-thing or nowhere in particular. Thus indeterminate *being* is not-being, non-being or nothing, since “to be” means to be something in particular. This is just another way of saying that being and nothing are opposites and yet they are exactly the same.

Becoming

This is heavy stuff, to be sure, but it gets much easier from here. Just as the origin can only be posited retrospectively, just as there is no first without a second, the difference between being and nothing can be grasped only from the perspective of what emerges from the interplay of the two -- becoming. “What is the truth is neither being nor nothing, but that being -- does not pass over but *has* passed over [*nicht ubergeht, sondern ubergegangen ist*] -- into nothing, and nothing into being” (82, my emphasis).

This is an important point because it indicates that being and nothing were in motion from the start. Thus the origin of the *Logic*, in being and nothing, can be known only through its subsequent development, namely in becoming. The simplest way to think of how becoming emerges from being and nothing is to examine the history of life on our planet. It is a story of the ceaseless process of coming out of virtual nothingness and into being (birth, coming-to-be), and passing over from being into nothingness (death, ceasing-to-be). “[B]eing passes over into nothing, but nothing is equally the opposite of itself, transition into being, coming-to-be. This coming to be is the other direction: nothing passes over into being, but being equally sublates itself and is rather transition into nothing, is ceasing to be” (106).

The following illustration might help explain how something negates itself and turns into its opposite, as being and nothing do in becoming becoming. Imagine that human beings and the atmosphere in us and above us constitute being, in Hegel’s sense. Human beings force excessive amounts of carbon dioxide and other gases into the atmosphere. These gases are also part of being. So human beings and their greenhouse gas emissions, which are part of being, negate another part of being -- the atmosphere's capacity to relay heat back into the vacuum of space. Thus Being negates itself by making the atmosphere perform the opposite function than it had been performing.

In Hegelian argot, Being negates itself by opposing itself to itself. It does so by turning into its opposite, Nothing. This movement to and fro is becoming. Becoming is the *process* resulting from the movement between being and nothing. Becoming can also be characterized as the process through which Earth's surface temperature is raised by negating the atmosphere's capacity to allow infrared radiation to escape. As depicted in

Figure 1-7, becoming is the constant movement of infrared radiation into Earth's atmosphere, to the surface, back up the atmosphere, back down to the surface as a result of greenhouse gases, back up to the atmosphere, back down to the surface as a result...and the process is perpetually repeated.

Determinate Being

The process of becoming yields stable results. For instance, the perpetual motion of infrared radiation bouncing back and forth between the Earth's surface and upper atmosphere results in surface warming. Surface warming affects another perpetually active process -- climate. And though the results of global warming are not what we may call "stable," they are stable in the Hegelian sense that they are concrete determinations of a process; the process of becoming. "Becoming," Hegel writes, "is an unstable unrest which settles into a stable result...It is the unity of being and nothingness which has settled into a stable oneness" (106). As such, becoming is determinate being (*Dasein*).

Although being, nothing, and becoming get all the press, the transition from becoming to determinate being is more important. This is because it is the seminal instance of the transition from an abstract or fluid process to a concrete result. Hegel's thoughts betray him when he writes that "[i]t is not mere being, but determinate being [*Dasein*], etymologically taken, being in a certain *place*; but the idea of space is irrelevant here" (110). *Dasein* is a generic term for existence. It literally means 'there-being or being which is there.' So, returning to the example above, determinate being is 'there but not-there.' Since determinate being is "the simple oneness of being and nothing" (109)

the 'here' of determinate being corresponds to 'being', while 'not-there' defines its non-being or nothingness.

The catch is that a particular 'here' is *also* 'not-here' for any number of other places that one would like to designate as 'here.' 'Here' at my desk means 'not-there' in the living room, in the kitchen, or out in the yard. But 'here' in the living room means 'not-there' at my desk. 'Here' and 'not-there' (at my desk, for example) is the same place because any particular 'here' (at my desk) is 'not-there' for an infinite number of others 'heres' (in the kitchen, out in the yard, in China, on the moon). Even though 'here' and 'not-here' are constantly flip-flopping, we can still pin down certain spatial aspects because 'here' and its opposite 'not-here' are the same place -- the "simple oneness of being and nothing."

The connection between this spatial analogy and global warming has already been stated. Both are fluid processes with determinate, or stable, results. Now "stable" does not mean "static," since for Hegel everything is always in motion. Stable, we might say, means that you can pin down, or empirically verify, *the existence [Dasein]* of the results of the processes (of becoming). For instance, scientists predicted in 1981 and 1990 that the existence of global warming would be verified around the year 2000. Sure enough, the processes they discerned yielded determinate results.

I am suggesting that being, nothing, becoming, and determinate being are **in** (or are) nature in all the ways I suggested in the Introduction. With the category of "Quality," we now turn to the constitutive features of the results of becoming. Figure 1-9 demonstrates the "stable" results of the process of human-induced global warming.

Comparison between modeled and observations of temperature rise since the year 1860

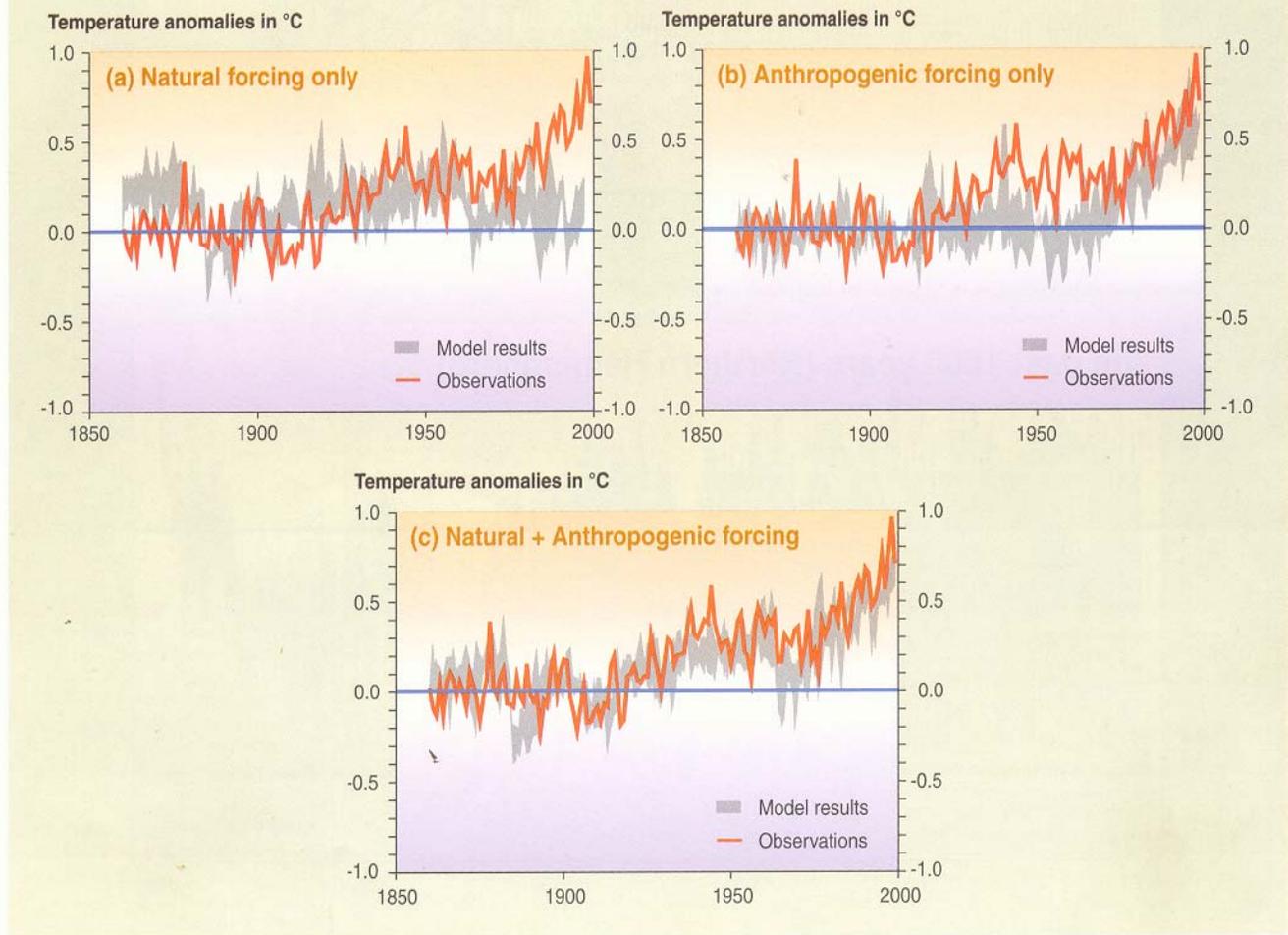


Figure 1-9. A climate model can be used to simulate the temperature changes that occur from both natural and anthropogenic causes. The simulations represented by the band in (a) were done with only natural forcings: solar variation and volcanic activity. Those encompassed by the band in (b) were done with anthropogenic forcings: greenhouse gases and an estimate of sulfur aerosols. Those encompassed by the band in (c) were done with both natural and anthropogenic forcings included. From (b), it can be seen that the inclusion of anthropogenic forcings provides a plausible explanation for a substantial part of the observed temperature changes over the past century, but the best match with observations is obtained in (c) when both natural and anthropogenic factors are included. These results show that the forcings included are sufficient to explain the observed changes, but do not exclude the possibility that other forcings may also have contributed. (Text and graph reprinted from IPCC, 2001, 50).

Quality

We should recall that "Quality" is also the parenthetical title of Section One, Book I, which stands in contrast to "Quantity" in Section Two. Of course, quantity and quality turn out to be inseparable. First, we need to develop a better sense of what Hegel means by quality.

As the *Logic* progresses, it becomes more specific, or increasingly determinate. Another way of stating this is that the negations by which it proceeds become more specific. The most general negation is being and nothing negating each other, which results in becoming, and becoming begets the more specific result of determinate being. Determinate being, too, can be further specified by way of negation, that is, by way of relating to what it is not or non-being. The specification of determinate being is quality.

Ordinarily we think of quality as a characteristic or feature of "something" (the next category). For example, in the phrase "he has some redeeming qualities" the qualities are a property of something or belong to something; as if the qualities are merely attached to something, in this case a person. Hegel's category of quality is much broader. Quality for Hegel determines what something is in its entirety. Quality is not a property or feature of something. Quality *is* that something.

True to form, what something is, its quality, is determined by what it is not. Every determination is the result of negation. We said earlier that the 'here' of determinate being corresponds to being, while the not-there of determinate being corresponds to its non-being. The latter, Hegel emphasizes, should not be underestimated: "in *reality* as quality with the accent on *being*, the fact is concealed that it contains determinateness and therefore also negation. Consequently, reality is given

value only as something positive from which negation, limitation, and deficiency are excluded...but it [negation] is a *determinate* being, a quality, only determined with a non-being.” (111). The positive being of 'here' where I am standing takes on significance only because it is the 'not-there' of any number of places in the universe. Inspect where you are right now while you are reading this sentence. You are at this particular point in space because *you are not* anywhere else. So where you are not defines where you are. This is exactly Hegel's point with regard to quality, or what may be called quality "in general": what something is not determines what it is.

Consider one of our main villains, CO₂. A carbon atom is attached to two oxygen atoms. What gives CO₂ its particular properties is that a carbon atom is *not* attached to one oxygen atom, nor is it attached to three oxygen atoms, nor *n* number of oxygen atoms. All other possible arrangements besides CO₂ are the non-being of CO₂. These other possible arrangements determine CO₂ by not being CO₂.

Something

Let's examine more closely the notion that all other possible arrangements besides CO₂, the non-being of CO₂, determine what CO₂ is. We would only anoint ourselves masters of the obvious by declaring that CO₂ is not CH₄ (methane) nor is it N₂O (nitrous oxide) nor is it any of the chlorofluorocarbons or any other greenhouse gas. All these gases *are* different qualities, and they interact differently with the atmosphere because of their qualities (see Figures 1-10 and 1-11). So there has to be a more specific negation that gives CO₂ its quality. The more specific negation negates that to which CO₂ is more closely related. The reason why CO₂ traps infrared radiation and does not asphyxiate us in our homes, like CO (carbon monoxide) does, is that there is a *limit* separating CO and

CO₂. What makes CO₂ what it is, what gives it its quality, is that it is limited or negated by that to which it is more closely related. According to Hegel, this holds for CO₂ as much as for N₂O, CH₄, and everything else in the world. “Quality, taken in the distinct character of *being*, is *reality*; as burdened with a negative it is *negation* in general [as just described with CO₂ in quality in general]...which further on is determined as limit, limitation" [as described with something]" (111). As with our example of CO₂, the "negated by all other possible arrangements" of quality in general gives way to "negated by that to which it is more closely related" of the category of something. The quality of something -- or more appropriately, the quality which *is* something -- is more specific than being, nothing, becoming, determinate being, and quality in general because the negations that determine it are more specific.

Greenhouse gas	Atmospheric lifetime (years) ^a	Relative instantaneous contribution to warming ^b	Relative total contribution to warming ^b
CO ₂	50–200 ^c	53.2%	80.3%
Methane	10	17.3%	2.2%
CFCs	65, 130 ^c	21.4%	8.8%
Nitrous oxides	150	8.1%	8.7%

Figure 1-10 (top) CO₂, CH₄, N₂O, and CFCs (chlorofluorocarbons) contribute differently to global warming because of their qualities. (Reprinted from van Kooten, 2004, 5; original source material found there).

(a) Global atmospheric concentrations of three well mixed greenhouse gases

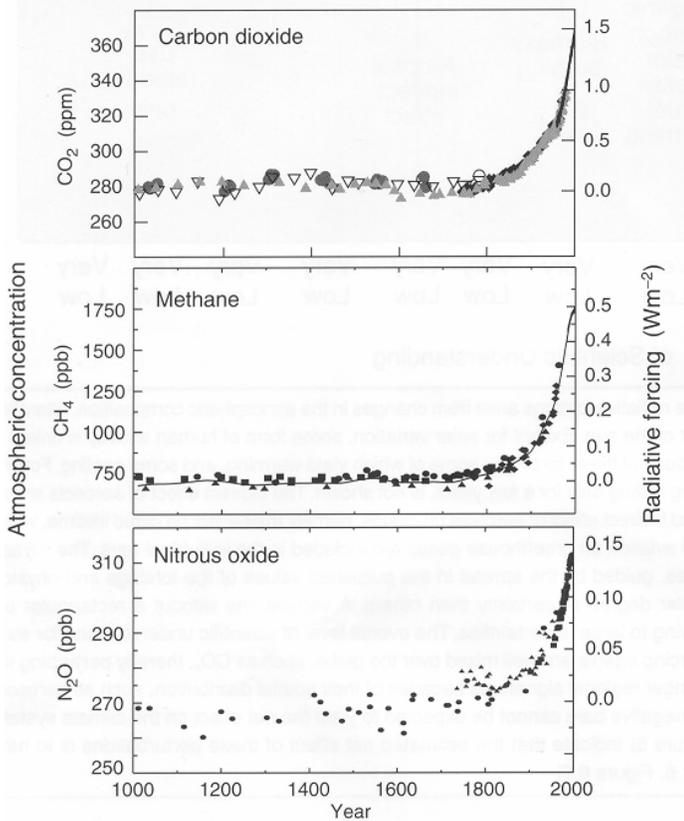


Figure 1-11. Long records of changes in atmospheric composition. (Reprinted from IPCC, 2001, 155).

Something is a landmark category because it is "the *first negation of negation*, as simple self relation in the form of being" (115). As in algebra, for Hegel two negatives make a positive. However, according to Hegel, the only way to determine a positive quality is through two negations.

We have already laid bare the *modus operandi* of negation of negation. CO₂ is not C₀, C₂₀₂, and C₂₀. C₀₂ is negated by that to which it is closely related. When these three negations are themselves negated we arrive at a positive quality -- CO₂. The same

holds for CO. It is not C02, C20, or C202. Negate these negations and we arrive at a positive quality -- C0. Two important principles are at work here. The first is that we always start with a negation, and then negating that negation yields a positive quality. The second is that, as we have seen, what something is not is just as much a part of it as what it is.

Something and Other

It is easy to lose sight of this point in the dialectical gyrations of the section entitled "something and other." The crucial thing to bear in mind is that something or the self is the positive value or quality, while the other is its negation or its negative value. We shall now apply the second principle above -- what something is not is just as much a part of it as what it is -- to passages from the three numbered sections of "Something and Other" in order to clarify the categories at work.

1. The other simply by itself is the other in its own self, hence the other of its own self and so the other of the other -- it is, therefore, that which is absolutely dissimilar within itself, that which negates itself, *alters* itself. But in so doing it remains identical with itself, for that into which it alters is the other... but what is altered is not determined in any different way, but in the same way, namely, to be an other; in this latter, therefore, it only unites with its own self (118).

This passage expresses one of Hegel's most frequently employed dialectical maneuvers. Say there are two things, something and other. The other is also a something; it is another something. So the first something is an other to the other something. Something and other, though they are two different things, are basically the same. Suppose CO₂ is something and CO is other than this something. If CO₂ is altered and loses an oxygen atom it becomes CO. CO₂ becomes *another something*. Therefore CO₂ (something) "remains identical with itself" in becoming CO inasmuch as it becomes another

something. These complicated dialectical details give expression to a more general, and more significant, point. What something is not, its other or "the other in its own self," is just as much a part of it as what it is. As before, it is determined as *this* something because it is not these other somethings. The negative value of CO is just as much a part of CO2 as the positive value of CO2. In fact, there would be no positive value of CO2 were it not for all the other somethings (CO, C2O2, etc.) that it is not. In the next number Hegel begins to explain how the negative value can be "part of" the positive quality.

2. Something *preserves* itself in the negative of its determinate being [*Nichtdasein*]; it is essentially *one* with it and essentially *not one* with it. It stands, therefore, in a *relation* to its otherness and is not simply its otherness. The otherness is at once contained in it and also still *separate* from it... (119).

We just covered this point above. When CO2 (something) turns into CO (another something) CO2 is "one with" or "preserves itself" in the negative of its determinate being inasmuch as a something turns into another something. And yet, clearly, CO2 is different or separate from CO. The negative value or otherness of CO2 is at once contained in it, or part of it, and still separate from it. Hegel completes the thought in the following number.

3. Something is *in itself* in so far as it has returned into itself out of the being for other. But something also has *in itself* (here the accent falls on *in*) or *within it* a determination or circumstance in so far as this circumstance is outwardly *in it*...(120)

To maintain that what something is not is just as much a part of it as what it is is to maintain that not being CO, C2O, and C2O2 is inscribed in the heart of the positive quality of CO2. Number 3 above is the crystallization of the thought that will drive the *Logic* forward from this point on. That to which something is related is *in* or *within* that something since these relations determine what that something is. In the opening section, I pointed out that the *Logic* incorporates its presuppositions; it internalizes that to which it

is externally related. Hegel is describing this very movement in emphasizing that something has *in itself* (with the accent falling on *in*) its external determinations or relations. CO₂ is determined as a positive quality because it has *within it* the negative values of CO, C₂₀, and C₂₀₂. Hegel ties things together in the final paragraph: "The determinateness thus reflected into itself is, therefore, again, in the simple form of *being*, and hence is again a quality: *determination*" (122). CO, C₂₀, and C₂₀₂ are a reflection-into-self of CO₂ because they are the other somethings of paragraphs 1 and 2, and CO₂'s relations to these other somethings determine the positive quality of CO₂. As stated by paragraph 3, the relations to these other somethings are within CO₂ even as the other somethings remain outwardly separate from it.

At first it may seem odd that relations are within something even though that to which something is related is outwardly separate from it. Physicist Brian Greene gives an example that helps clarify this idea. He is discussing how the views of Austrian physicist and philosopher Ernst Mach came to have such a deep impact of Einstein's theory of relativity. Greene explains:

When the airplane you are on is accelerating down the runway, when the car you are in screeches to a halt, when the elevator you are in starts a climb, Mach's idea implies that the force you feel represents the combined influence of all the other matter making up the universe. If there were more matter, you would feel greater force. If there were less matter, you would feel less force. And if there were no matter, you wouldn't feel anything at all. So, in Mach's way of thinking, only relative motion and relative acceleration matter. *You feel acceleration only when you accelerate relative to the average distribution of other material inhabitants of the cosmos.* Without other material -- without any benchmarks for comparison -- Mach claimed there would be no way to experience acceleration (Greene, 2004, 37, original emphasis).

Your relation to all the other matter in the universe is **in** your experience of acceleration. Were the other material inhabitants of the universe to change, so would your experience of acceleration. This is exactly the same point Hegel is making: the positive quality of

something is determined by relations to other somethings. These relations that are within that something even though the other somethings remain outwardly separate from it.

Determination, Constitution, Limit

Hegel's account has a particular bearing on continuing efforts to fit together the pieces of how the external relation of human influence is found *within* internal climatic processes. In "Determination, Constitution, and Limit" Hegel holds: "Constituted in this or that way, something is involved in external relations" (124). Relations constitute what something is. Or again, "something *through its own nature* relates itself to the other, because the otherness is posited in it as its own moment; its being within self includes the negation within it, by means of which alone it now has affirmative determinate being" (125). There is no pre-existing internal nature of something which subsequently enters into external relations. The relations in which something is involved *already constitute* what that something is. Alter the relations of which something is comprised and that something's nature will also be altered. In Greene's example, if there were more or less matter in the universe you would feel more or less force in accelerating. This is because your experience of acceleration is constituted by your relation to all the other material inhabitants of the universe.

In Hegel's terms, when one pushes the external relations of which the internal nature of something is constituted beyond a certain limit (say, more or less matter in the universe), the internal constitution of something is altered (your experience of acceleration is altered). "Something has its determinate being *outside* (or, as it is also put, on the *inside*) of its limit" (127). In this example, any alteration in the matter of the universe would in principle entail a commensurate alteration in your experience of

acceleration. We will explore this scenario in more detail below. The point Hegel has in mind in this section is that the limit, the external relations, that comprise the internal nature of something can vary within a certain degree before that something's internal nature is altered. Taking into account the title of the section, when a *limit* is altered the external *determinations* (relations) that *constitute* the internal nature of something alter the nature of that something.

This is the case with anthropogenic interference with the climate system. When greenhouse gases in the atmosphere reached a certain limit, it caused significant warming. But the oceans delayed warming for a few decades by absorbing the heat in their upper layer. The oceans, however, could only absorb so much. When the oceans reached a certain limit, significant surface warming occurred. And, when surface warming reaches a certain limit, climatic processes are altered. Human beings are "the determinate being *outside* (or, as it is also put, on the *inside*) of its [the climate system's] limit." The climate system (itself a system of relations) is related to human activity, and when human activity pushed this relation beyond a certain *limit* human beings began to *determine* the climate by altering the system of relations that *constitute* climatic processes.

The moral is that there is no sacred inner core, no inviolable and invariable nature, that cannot be altered through altering the relations through which something is determined and constituted. This is as true for individual human beings as it is for economic and climatic processes. With respect to the latter, it was long thought that there was an inviolable internal "Balance of Nature" that prevented human beings from altering

the planet's climate. That myth has long been exploded. Figure 1-12 addresses the former.

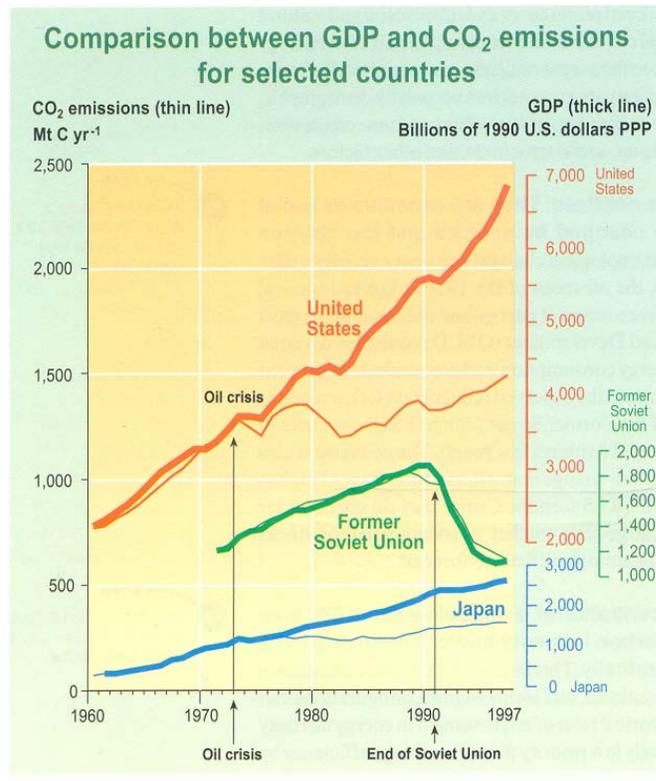


Figure 1-12. The response of the energy system, as indicated by the emission of CO₂ (expressed as carbon), to economic changes, indicated by GDP (expressed in Purchasing Power Parity terms). The "oil crisis" -- during which energy prices rose substantially over a short period of time -- led to an almost immediate and sustained divergence of the formerly closely linked emissions in most developed countries: Japan and the United States are shown as examples. At the breakup of the Former Soviet Union, the indicators remained closely linked, leading emissions to drop rapidly in tandem with the declining GDP. (Reprinted from IPCC, 2001, 94)

As Figure 1-12 shows, the oil crisis in the 1970s was an external relation that changed the nature of the link between GDP and CO₂ emissions. That GDP can grow without increasing emissions is precisely what opponents of mitigating climate change dispute.

Unlike the clear link between GDP and CO2 emissions, it is hard to discern the extent to which external human relations determine the internal constitution of climatic processes. With regard to the 35,000 deaths caused by the summer heat-wave that swept through Europe in 2003, Stott *et al* write: "It is an ill posed question whether the 2003 heatwave was caused, in a simple deterministic sense, by *modification of the external influence* on climate...because almost any such weather event might have occurred by chance in an unmodified climate" (Stott *et al*, 2004, 610, my emphasis). Still, they conclude that "it is very likely (confidence level >90%) that human [external] influence has at least doubled the risk of a heatwave exceeding this magnitude" (610). Similar studies are beginning to reveal that warmer water temperatures, caused by global warming, increase the intensity of hurricanes.

Even though most of those who perished from the 2003 heat wave, mostly the elderly, were already at death's door, the numbers are staggering. "The French authorities estimate that the 2003 heatwave caused more than 14,000 'excess deaths' nationwide" (Allen and Lord, 2004, 551). The Hegelian question of limits, of how external relations change internal constitutions or processes, may be the topic of lawsuits to come. If Stott *et al* are right, our relation to the climate system has already crossed certain limits by loading the weather dice. The immediate cause of the heatwave in Europe was a persistent anticyclone over northwest Europe. In addition to their 90% confidence that human influence has doubled the risk of a heatwave such as that of 2003, Stott *et al* argue that external human influence increased the risk of an anticyclone causing such a heatwave by around a factor of four (Allen and Lord, 551).

Allen and Lord sum up the scenario this way:

If a dice is loaded to come up with six, and it comes up six, there is a clear sense in which the loading 'helped cause' the result. If the loading doubles the chance of six, it follows that half the sixes you get are caused by the loading. The question of 'which sixes?' is meaningless. If you throw a one, it does not prove the dice was not loaded, so the 2004 washout [of decreased temperatures] has almost no effect on conclusions about 2003 (551).

They continue:

Suppose it is confirmed, at a reasonable level of confidence, that past greenhouse gas emissions doubled the risk of these local temperature anomalies. This would surely meet or exceed the threshold at which a court might conclude those emissions were, in a loaded dice sense, likely to have been a 'legally effective' cause of death and hence that some victims might have grounds to claim compensation against those responsible for the emissions (551).

Along these lines, a 2004 lawsuit by eight US states and New York City aim to force five power companies to reduce emissions. The island nation of Kiribati is fighting for the right to sue the United States for its role in emitting large quantities of carbon dioxide into the atmosphere. The subsequent warming expands sea-water, causing rising sea levels to submerge their island homes. Past emissions of the United States accounts for about one-third of today's climate change (Victor, 2004, 25). Moreover, "at the close of the 1990s U.S. emissions were already 15 percent above 1990 levels and rising at 1.3 percent per year" (Victor, 2004, 4). Such considerations will obviously factor into how, in a loaded dice sense, current and past emissions are a "legally effective" cause of suffering and death.

Finitude

We have just seen how "determination, constitution, and limit" are involved in climate change. And we have seen that there is some uncertainty with regard to determining the human influence upon climatic processes. Both aspects involve finitude, or limitedness. The first aspect is the finite nature of things. The second is the finitude of

our perspective on the nature of things. Hegel deals mostly with the former, so we shall address it first. Given what we have just learned about determination, constitution, and limit, Hegel's definition of finitude naturally follows. "When we say of things that *they are finite*, we understand thereby that they not only have a determinateness, that their quality is not only a reality and an intrinsic determination, that finite things are not merely limited -- as such they still have determinate being outside their limit -- but that, on the contrary, *non-being constitutes their nature and being* (129, my emphasis)." "The finite not only alters, like something in general, but [when it is altered] it *ceases to be*" (129). The non-being of C02 is CO, C20, and C202; the non-being of C02, as we have witnessed repeatedly, constitutes its nature and being. C02 is *limited by* CO, C20, and C202. Should this limit be crossed in any direction -- should C become C0, or 02 O, and so forth -- then C02 ceases to be. Hence CO2 is finite because it is limited by its non-being.

Recall that human civilization has been able to flourish "during a warm period that was far more stable than any other period in the last 400,000 years" (Weart, 2003, 186). Because a temperate climate helped give birth to human civilization "the being as such of finite things [as a temperate climate] is to have the germ of their decease as their being within self: the hour of its birth is the hour of its death" (129). The hour of our birth was the hour of the death of the unaltered climate system that gave birth to us. I don't mean for this point to take on a moral tone. It is not as though the climate will get upset if it is altered. The point is that the climate system is finite in that it can be altered by external relations. There is a certain amount of irony in the fact that the temperate

climate that gave birth to human civilization may well *cease to be* because it gave birth to human civilization.

Now that we have seen the finitude of the planet's climate system, we can turn to the finitude of our perspective on it. Limitedness of knowledge is uncertainty. In Hegelian terms, explanations and predictions carry the germ of their opposite within them; the opposite being that the projected state of affairs might not obtain. That is why the language of analysis and prediction is the language of probability. As Weart notes, "scientists rarely label a proposed answer to a scientific question 'true' or 'false', but rather consider how likely it is to be true. Normally a new body of data will shift opinion only in part, making the idea seem a bit more or less likely" (51).

Another example of finitude and probability drives this point home. Before the 1980 eruption of Mount Saint Helens, geologists were closely monitoring the situation and trying to keep the public informed. The question posed time and again to geologist Donald Mullineaux was 'would St. Helens erupt or not?' Dick Thompson described a particular press conference at which this question was asked repeatedly. "We cannot predict an eruption," he replied. The answer took the group by surprise. A burly man from the state forestry service asked, 'You mean to tell us that we as a nation can send a man to the moon and you can't predict if a volcano will erupt or not?' Yes, that's correct." (2000, 34). The problem was that many "found just getting clear advice from the [U.S. Geological] Survey was not easy. Mullineaux was a careful scientist and spoke like one; *nothing was certain, everything was a matter of probabilities*. It led Sheriff Les Nelson to say in frustration, 'Trying to pin down a geologist [is] like trying to corner a rat in a rain barrel" (36, my emphasis).

Like a volcano, the climate system is a capricious beast. The difference is that as we continue to poke the climate system with our sharp sticks there is no telling how it will react. One of the odd quirks of modern life is that only philosophers and so-called "lay-persons" demand absolute certainty; both philosophers and common folk want to overcome finitude, or limitedness. But limitedness is our lot. That's why every prediction and analysis entails an attendant probability.

It is possible for uncertainty to completely undermine analysis and prediction. This is especially true of the cost-benefit analysis of climate change, which we will examine in the section on quantum. Tol, for example, holds that his "analysis shows that the question 'is the uncertainty about climate change too large for expected cost-benefit analysis?' is not answered with an unambiguous no" (Tol, 2004, 267). Uncertainty is ineradicable. It is something we can mitigate but not overcome.

The trouble is that the major players in the greenhouse problem -- the climate system itself, economic processes, and public perception -- are all notoriously fickle. Uncertainty, however, is not an excuse for inaction. We know enough about global warming to predict most its threats and to mitigate or avoid some or most of its consequences.

Uncertainty, again, is simply something that must be dealt with -- with the realization that it cannot be overcome. The key to mitigating uncertainty is "transparency of assumptions and the use of as wide a range of eventualities (and their attendant probabilities) as possible" (Schneider and Kuntz-Duriseti, 2002, 79). If we predict five mutually exclusive eventualities and their attendant probabilities, only one of the eventualities can actually take place, or perhaps none will. The rest are the non-being of

the eventuality that did obtain. While operating with uncertainty, projecting non-being (unrealized possibilities) is a necessary condition for projecting the state of affairs that does obtain (the realized possibility). (See Mastrandrea and Schneider, 2004 for an assessment on how probabilistic frameworks and methods can and should be used in policy decisions for avoiding dangerous anthropogenic interference with the climate system.) We will examine this in much more detail below with regard to cost-benefit analysis in the section on "Quantum."

Limitation and the Ought

Finitude can be seen as the natural extension of the movement that started with being and nothing. From the opening section of the *Logic* to the present we have repeatedly witnessed that non-being, or negation, is inscribed in the heart of things. In the present section and the next "Remark" Hegel is targeting Fichte and Kant, who work against non-being in their fruitless attempts to overcome it. Hence the title of the section: limitation, non-being, is something that ought to be overcome. This ought is tantamount to the demand for absolute certainty, which unreasonably seeks to eradicate limitedness.

Hegel avers:

Determination and constitution showed themselves as *sides* for external reflection; but the former already contained otherness as belonging to the something's *in itself*; the externality of the otherness is on the one hand something's own inwardness, on the other hand it remains, as externality, distinguished from it, it is still externality as such, but present *in* the something (131).

This passage simply recapitulates what we have been working over for some time now.

The ought is defined by limitation or non-being. Skipping the niceties of Kant's and Fichte's views, for them the ought is a moral imperative to bring about a certain state of affairs. If the state of affairs is brought about the ought is no longer an ought; it is an

"is." Kant and Fichte are then faced with the dilemma of how to maintain the moral imperative of the ought. As Hegel points out in the passage above, the inwardness of the ought is the moral imperative making internal demands on every individual; the externality of the ought is the state of affairs that ought to be brought about. Both are the same thing, and when the external state of affairs obtains, the moral imperative of the ought automatically disappears. If I ought to feed my dog this evening, and then I feed my dog this evening, then the internal "ought" disappears because it becomes an external "is."

Kant and Fichte, then, try to keep the ought intact by maintaining that it can never be completely fulfilled; that the internal demand of the ought never ceases because there are always external states of affairs to be brought about. In other words, no matter what external action you take to make the world a better place the internal demand of the ought remains constant because *an imperfect world always offers* still more external states of affairs to be realized. For this reason, Hegel holds that the ought is contradictory: it can preserve itself only by raising itself above its own limitations, namely the limitation of being fulfilled. The ought can maintain itself as an ought only through never being fulfilled, never being turned into an "is." "Hence as the *ought*, something is *raised above its limitation*, but conversely, it is only as the *ought* that it has its *limitation*. The two are inseparable" (113). To posit the ought is necessarily to posit alongside it limitations, or non-being, that it cannot overcome. Without such insurmountable barriers, the ought would not be an ought; it would, again, be an is because the barriers have been overcome and the state of affairs realized.

The moral imperative of the ought raises important and little discussed ethical questions about our obligation (if there is one) to mitigate global climate change and its deleterious effects (see Singer, 2002, 1-50). First we should examine the limitations or barriers that need to be overcome should "the ought" in "we ought to mitigate global warming" take hold. Such limitations and barriers are summed up in Figure 1-13.

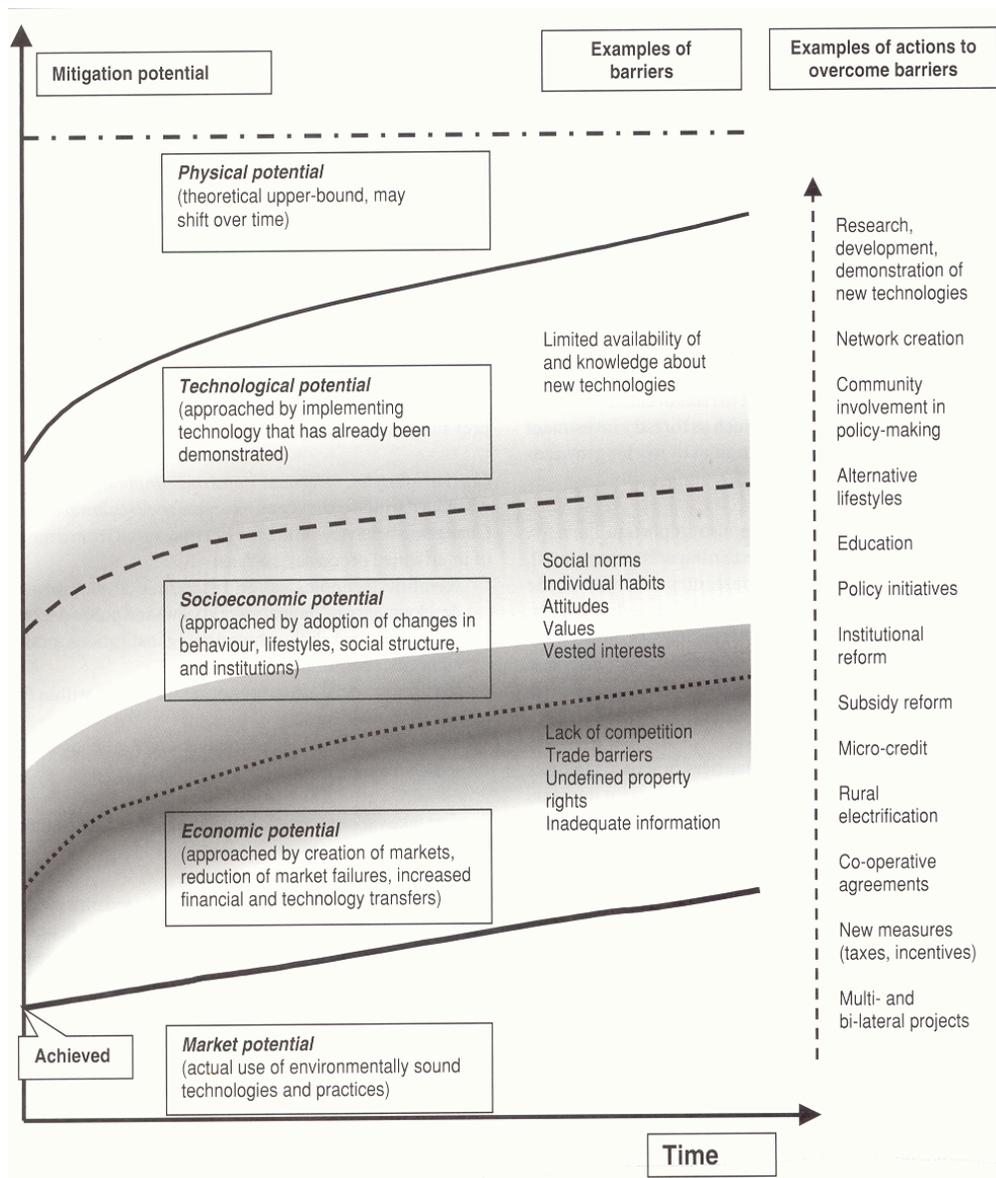


Figure 1-13. (Reprinted from IPCC, 2001, 329).

Notice where we are now, with "achieved," and the barriers that must be overcome for mitigation potential to increase. As above, to posit the ought in mitigating climate change is to posit alongside the ought barriers and limitations that have to be overcome, with the major exception that our view does not suffer from the metaphysical difficulties plaguing Kant and Fichte. The IPCC puts it thus:

A major barrier to the diffusion of technical progress lies in the vested interests [third tier from the top] who specialize in conventional technologies and who may, therefore, be tempted to collude and exert political pressure on governments to impose administrative procedures, taxes, trade barriers, and regulations in order to delay or even prevent the arrival of new innovations that might destroy their rents (330).

Certain companies and firms have a vested interest in maintaining the status quo because their profit margin depends on the status quo. They are *the* major barrier to mitigating climate change in that through funding elected representatives they have the power to kill policies designed to change the status quo and to inhibit the very inception of these policies.

I have thus far been speaking in Kant's and Fichte's terms, as though there is some deep moral foundation to the proposition "we ought to mitigate climate change." In reality, mitigating climate change is a matter of the principles upon which one acts; principles that are necessarily social in nature and have nothing to do with a "metaphysics of morals." Addressing climate change is above all an ethical issue. And as Hegel holds in his other works, morality is a matter of weighing and adopting ethical principles.

I will endorse the following moral principle. Human beings, regardless of race or nationality, and other animals ought not to suffer and die unnecessarily. "Unnecessarily" means when reasonable measures can be taken to prevent or ameliorate such suffering and death. In the case of climate change, the reasonable measures are policy options for mitigating climate change. My argument is that we ought to mitigate climate change in

order to prevent human beings and other animals from suffering and/or dying unnecessarily.

Clearly, no such moral principle is directly found in Hegel's *Science of Logic*. So I need to provide some sort of explanation for how this ethical principle relates to my account of the *Logic* and global warming. The explanation is rather simple. Hegel would view the ethical response to global warming as part of the phenomenon of global warming. The ethical principle is necessarily tied into the phenomenon. I explain this in more detail below in the feedback loop of Infinity. The ethical response to global warming is part of the feedback loop (see especially Figure 1-14). The suffering, death, and environmental degradation that will probably be caused by global warming should elicit sort of ethical response; and our response to global warming determines whether it will be mitigated or exacerbated. My ethical argument, then, is not an alien imposition on the *Science of Logic*, but is actually native to Hegel's thinking. This is because global warming internally generates its own response, just as each category of the *Science of Logic* internally generates its own movement to the next category.

Infinity

The first chapter on Infinity in the *Science of Logic* is, to my mind, the third most important chapter on the book, behind "Actuality" and "Teleology." After reading this chapter, you'll never be able to look at infinity like you did before. As we just saw, the finite always has its non-being lying beyond it in the form of an external limitation or barrier that ought to be overcome. Overcome one barrier and another barrier presents itself; overcome that barrier and... "The progress to infinity is, consequently, only the

perpetual repetition of one and the same content, one and the same tedious *alternation* of this finite and infinite" (142). The infinite, in other words, always lies on the other side of the finite. This is why the ought for Kant and Fichte is an infinite task. No matter how many oughts you turn into ises the imperfect state of the world will always offer an infinite number of barriers and obstacles to surmount. No matter how far the *limit* of the finite is extended the infinite always lies on the other side of this limit, as something qualitatively distinct from the finite. Hegel's calls this conception of infinity "the spurious infinite." The spurious infinite is the proverbial carrot that perpetually hangs in front of the donkey's nose. Every time the donkey moves forward and tries to grab the carrot, it inches away ever so slightly.

Similar arguments are made about mitigating climate change. We shall see below that significantly curbing emissions cannot be accomplished in one fell swoop. It requires many small finite steps which, when combined, can make a difference.

"The infinite as thus posited over against the finite, in a relation where they are as *qualitatively distinct others* [my emphasis], is to be called the *spurious infinite*" (139). Hegel's critique of Kant and Fichte is equally a critique of a popular notion of infinity and argument above: that there is some barrier, some limit, at which the finite ends and the infinite begins, and this barrier cannot be crossed by the finite no matter how far the limits of the finite are extended.

Suppose that the universe is finite and we took a spaceship to its very edge. Hovering at the limits of the universe, we stare out into the infinite abyss. Imagine, also, that because the finite universe is expanding into the infinite abyss we are progressively able to go one step beyond the edge of the universe, but beyond that point the finite ends

and the infinite begins. If we do this over and over again we could, as Hegel remarks, perform the same tedious act for hundreds of billions of years because the infinite always lies on the other side of, or is qualitatively distinct from, the finite; "each in its own nature is separate, in fact absolutely separate from the other" (145).

The truth is that we are not peering out into infinity from the finite any more than the task of mitigating climate change is an infinite task. By definition, infinite means unlimited. But if the infinite always lies on the other side of the finite, if the infinite is absolutely separate from the finite, then the infinite is *limited by* the finite. There is something that lies outside infinity, namely the finite. So the spurious infinite is not infinite because it is not unlimited; the spurious infinite is finite, since to be finite is to be limited. True infinity, what Hegel's dubs "Affirmative Infinity," is the "infinite." The in-finite is **in** the finite, or encompasses the finite, as the very term "infinite" suggests. "In *saying* what the infinite is, namely the negation of the *finite*, the latter is itself included in what is *said*; it cannot be dispensed with for the definition of the infinite. One only needs to *be aware of what one is saying* in order to find the determination of the finite in the infinite" (143). The infinite and the finite are the same thing.

The relation between the finite and the infinite is but the latest installment in how something's relation to its non-being is really a relation to itself. The wall between infinite and finite is actually a bridge uniting the two. For example, our many finite efforts to mitigate climate change form a bridge that leads to the ultimate goal.

In the more formal Hegelian movement, the finite has become the content of the infinite. By definition, the infinite must contain the finite. True infinity is therefore

unlimited in the sense that it is *self-limited*. That is, there is nothing on the other side of the infinite or distinct from it by which it is limited. In being limited by the finite the infinite is limited by itself in that the finite is part of the infinite. To see how, let's look at a few examples.

The relation between the infinite and the finite described by Hegel is what is known as "feedback loop", the operative word being "loop." The infinite loops back upon itself through its relation to the finite; the finite loops back upon itself through its relation to the infinite. Hegel has described a self-enclosed infinite system. So any particular element in a mutually determinate system loops back upon itself through its relation to the other elements. The loop works something like this: A affects B, which in turn affects C, which affects D, which then affects A, which affects B, and so the loop spins. Or it could spin in reverse direction: A affects B, B affects C, C in turn affects B, which affects A, which affects B. The point is that all the elements in a self-enclosed infinite system are mutually related and mutually determine one another.

Infinity adds an additional layer of complexity to the account of relations developed above. We learned that relations are *within* something even though that to which something is related is *outwardly separate* from it. Roughly, the finite are parts or elements while the infinite is the relations between these parts or the sum total of the parts and their relations.

The first example of a feedback loop is from Mars. In 1971 the spacecraft Mariner 9 settled into orbit around Mars during a massive, though very rare, dust storm that shrouded the entire planet. The dust "profoundly altered the Martian climate, absorbing sunlight and heating the planet by tens of degrees" (Weart, 88). The clear

lesson was that haze could indeed warm an atmosphere. "Moreover, it seemed that the temporary warming had reinforced a pattern of winds that had kept the dust stirred up. It was a striking demonstration that feedbacks in a planet's atmospheric system could flip weather patterns into a drastically different state" (88). The feedback loop is: wind stirs dust, dust warms the atmosphere, warming reinforces patterns of winds, wind stirs dust, dust warms the atmosphere...

Most likely, all drastic (and less drastic) climate change on earth occurs through a feedback loop. In an ice age, for example, light reflects off advancing sheets of ice (known as "albedo") instead of being absorbed, thereby having a cooling effect, allowing for more ice to advance, thus for more albedo... Of course, more than albedo constitutes the necessary feedback for an ice age. The "snowball earth" hypothesis holds that 600-700 million years ago conditions were such that the feedback loop kept spinning until the entire planet was under a sheet of ice for millions of years. The only surviving life clung to the sunlight penetrating the thin sheet of ice covering the tropics. The loop was eventually broken by volcanic activity, followed by extreme greenhouse conditions. In this period the planet shifted from temperatures averaging minus 40 degrees C (minus 72 degrees F) to sweltering heat unlike anything seen since. Almost three hundred million years ago, in the late Permian, volcanic eruptions in Siberia pumped enough CO₂ into the atmosphere to warm the world by about 5 degrees F. The increased temperature in the oceans led to disintegration of clathrate ices in the seabed mud. These are basically pockets of mud, located on the sea floor, containing methane gas. Once opened, these seabed vents pumped enough methane into the atmosphere to warm the world by 5 more

degrees. 95% of all life on earth went extinct. The loop was broken only when the gases in the atmosphere dissipated.

The following example will become embedded in the more complex feedback loop below. The African drought of the early 1970s redoubled concerns about the southward expansion of the Sahara desert and the role that biological systems play in climate.

In 1975, veteran climate scientist Jules Charney proposed a mechanism. Noting that satellite pictures showed widespread destruction of African vegetation from overgrazing, he pointed out that the barren clay reflected sunlight more than the grasses had. He figured this increase of albedo would make the surface cooler, and that might change the pattern of winds so as to bring less rain. Then more plants would die, and a self-sustaining feedback [loop] would push on to full desertification (Weart, 102).

Charney was as right as rain, though it took a few more years for computer models to show how a regional change in albedo could affect winds. The primary lesson is that "human activity could change vegetation enough to affect the climate" (Weart, 102).

The blue arrow in Figure 1-14 below represents this sort of scenario, although it is not listed in the box above it (see the explanation), while the yellow arrow next to it represents socio-economic impacts of a human induced change in the climate system, such as (most likely) the African drought. The yellow arrows represent the feedback loop of greenhouse warming.

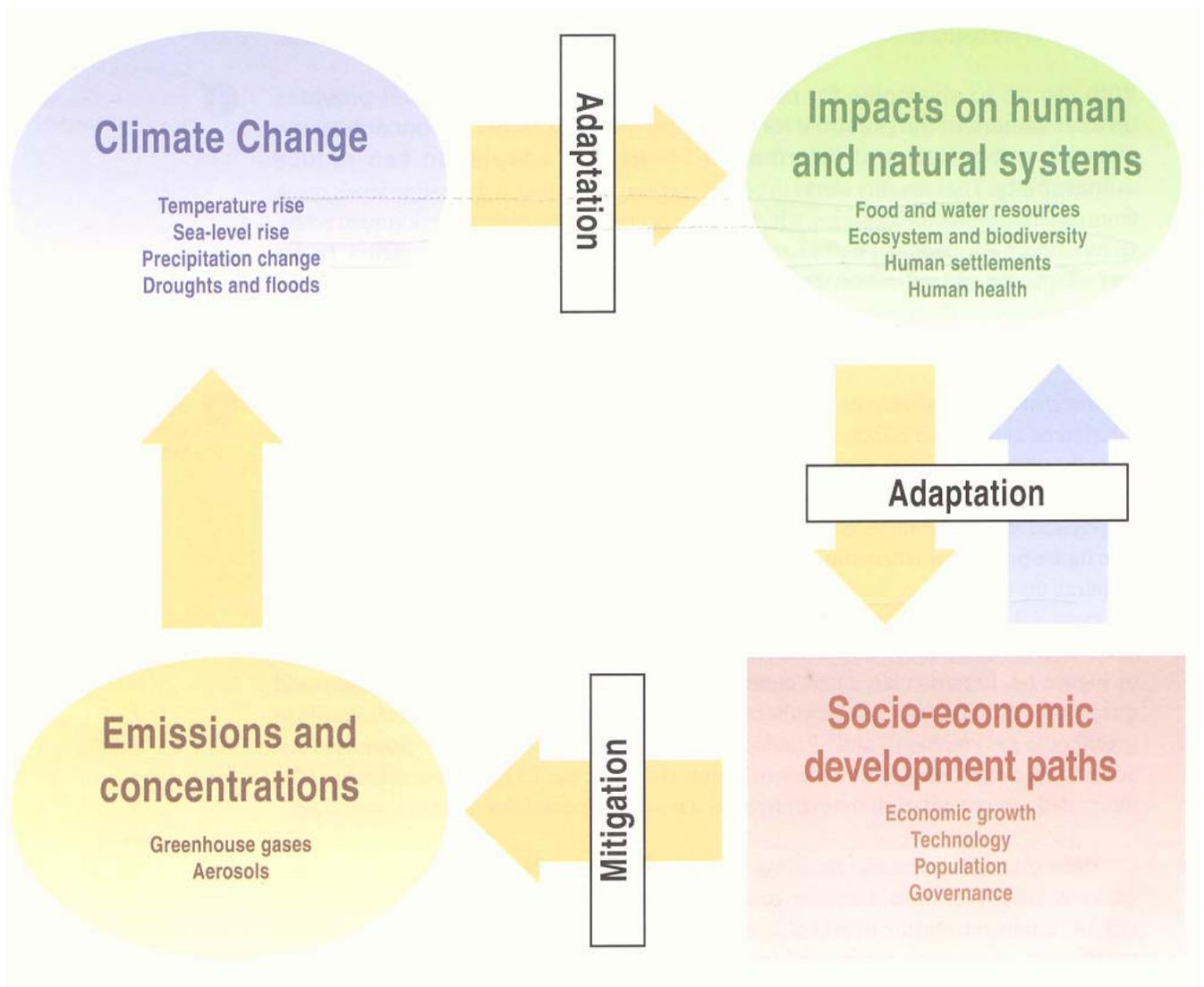


Figure 1-14. The yellow arrows show a full clockwise cycle of cause and effect among the four quadrants shown in the figure, while the blue arrow indicates societal response to climate change. There is a possibility of some feedback between the changes in these systems and the climate (not shown), such as albedo effects from changing land use, and other, perhaps larger, interactions between the systems and atmospheric emissions (e.g., effects in changes of land use (again, not shown)). These changes will ultimately have effects on socio-economic development paths. The development paths also have direct effects on the natural systems (shown by the anti-clockwise arrow of the development box) such as changes in land use leading to deforestation. This figure illustrates that the various dimensions of the climate change issue exist in a dynamic cycle, characterized by significant time delays. Both emissions and impacts, for example, are linked in complex ways to underlying socio-economic and technological development paths. (Text and figure reprinted from IPCC, 2001, 40).

Describing in detail how the loop in Figure 1-14 functions would require a long digression. The general picture should be clear: "the various dimensions of the climate change issue exist in a dynamic cycle." Suppose, for example, that economic and population growth continue, while technology does not change and governance does nothing to reduce emissions. This would hamper socio-economic developmental paths, though in the short term it would not hamper the developmental paths of the wealthy societies historically responsible for climate change. The initial victims of climate change will be the poor. Those living in countries without an infrastructure adequate for coping with food shortages, disease, refugees, and so forth will bear the brunt of suffering and death resulting from climate change. In the long term, socio-economic paths and natural systems in developed countries will also be degraded. Of course, the converse is also possible -- improvements could be part of the feedback loop. As we can see, our ethical response to global warming, in the form of mitigation efforts, is part of the dynamic circle. Our ethical response (or lack thereof) emerges from phenomenon of global warming and, in turn, affects global warming (it will be mitigated, or not).

It is also important to bear in mind that in the feedback loop the "causality works in both directions. Different stabilization levels [which may come from our ethical response] result from different emission scenarios, which are connected to underlying development paths. In turn, these development paths strongly affect adaptive capacity in any region" (IPCC, 39). Just as Hegel's infinite is a self-enclosed system whose components mutually determine one another, "*all the parts of the climate change problem interact mutually*. Changes in one part of the cycle influence other components in a dynamic manner, through multiple paths" (39, my emphasis).

Being-for-Self

When the infinite was confronted with the finite -- with its negation, non-being, that to which it was externally related -- the infinite internalized the finite. The infinite made the finite part of itself. The infinite negated its negation. Thus Hegel writes: "being-for-self is infinity which has collapsed into simple being; it is determinate being in so far as the negative nature of infinity, which is the negation of negation, is from now on only in the explicit form of immediate being" (158). Being-for-self is the immediacy of being because the infinite has internalized the finite, its externality. With respect to this externality, "the finite is present in its unity with the infinite...In being for self, negation is not present as a determinateness or limit, or consequently as a relation to a determine being which is for it an other" (159). Again, the external negation or barrier has been overcome, or sublated, by being absorbed into the internal structure of the infinite.

In the same vein, greenhouse warming is the externalization of human activity in the same way that the Golden Gate Bridge and the Empire State Building are externalizations of human activity. We characterized greenhouse warming as human activity negating the atmosphere's capacity to allow infrared radiation to escape. Recall, too, that I pointed out that the companies and firms mostly responsible for greenhouse gas emissions refuse to absorb the cost of polluting the global commons. The same point is applicable to the United States government. Clearly, what is at issue is the refusal of the government and firms to internalize this external negation. Nordhaus and Boyer capture this thought perfectly in their cost/benefit analysis of the "No Controls" (Baseline) scenario, to which we shall turn in the next chapter. The following sentence could have been written by Hegel: "Individuals and firms would adapt to climate change,

but governments and firms are assumed to take no steps to curb greenhouse gas emissions or *to internalize the greenhouse externality*" (2000, 123, my emphasis). What spins the feedback loop above is the action or inaction taken to mitigate emissions, to make the greenhouse externality being-for-self. And the feedback loop will reflect our failure or success in internalizing the external manifestations of our activity.

The One and the Many

I emphasized above that many finite steps are required to accomplish this purportedly infinite task; that is, internalizing the greenhouse externality is a matter of many small, finite measures. These many small steps add up to achieving one goal. Hegel's "the one and the many" exhibits a similar structure.

When the infinite and finite were dialectically united, the finite became the content of the infinite. Instead of having, as before, one something that is determined by its relations to other somethings, we now have many somethings, each determined by its relations to other somethings, and all these many somethings interact and determine one another. The many somethings interact and determine one another in a self-enclosed infinite system. Thus the finite is the many, and the infinite is the one system in which the many interact with each other. So taking many finite steps will reverberate throughout the one system.

Hegel's language is difficult in this section. The many finite ones, or many ones, are distinct from the one one, or the infinite one. Hegel's reasoning goes something like this. As self-related, the infinite contains its opposite, the finite, within it. The infinite is one, or the one one, because there can be only one infinity. The opposite of one is many. Therefore, since the infinite contains its opposite within itself, the infinite contains many

finite ones within it. The infinite one becomes the void. And the many finite ones become individual atoms floating in the void. Put differently, the one one is the space between and around the many ones (individual atoms).

This progression seems to proceed rather smoothly. The problem, however, is that Hegel never *deduces* the many ones from the finite content of the infinite (Clark, 88; Rinalidi, 321). He never shows how this finite content is dispersed into many individual atoms. As noted above in the Introduction, Findlay holds that Hegel rarely provides adequate transitions, or deductions, among his categories. So it would be fruitless to take him to task on this particular deduction, which is just a more glaring example of a general problem in the *Logic*.

It is worth considering what Hegel puts in place of a deduction. Hegel seemed to be well aware of the fact that he had not deduced the many either from the infinite one or from its finite content. In the section immediately prior to the one under consideration, "The One," he writes: "Attention may be drawn in advance to the difficulty involved in the following exposition of the *development* of the one and to its cause" (163), that is, how the many ones develop out of the one. The next sentence is the closest he comes to a deduction: "The *moments* which constitute the Notion of the one as a being-for-self fall *asunder* in the development [of the one]." The "moments" are the many ones that have "fallen asunder," or separated themselves out from the one one. The following is a summary of Hegel's method, which he provides *in lieu* of a deduction in the last paragraph of the section entitled "The one." The steps summarize the path we have repeatedly taken so far, and they are supposed to demonstrate how the many finite ones, the moments of the one one, "fall asunder" in the development of the infinite one.

- (1) Negation in general
- (2) *Two* negations (e.g., the finite and infinite each negate each other, as do the one and the many).
- (3) Two that are therefore the same (the finite and the infinite are the same in that each negates the other; the one is a negation of the many; the many is a negation of the one).
- (4) Sheer opposite (the infinite is the opposite of the finite; many is the opposite of one)
- (5) Self-relation, identity as such (the finite turned out to be identical with the infinite and vice versa; the many ones are still *ones*, thus the many is identical with the one)
- (6) Relation which is *negative* and yet to *its own self* (the infinite is both the opposite of and identical with the finite; the many ones are both the opposite of and identical with the one one) (163).

There is a simpler way to think about the one and the many, without so much dialectical jostling. Think of one phenomenon that is inseparable from its many constitutive features. Without the one there is no many; without the many there is no one. The United States is a prime example. Without the one, a federal government, there would not be many states. There would only be completely sovereign territories or nations which are not united with surrounding territories or nations. Without the many States, there is no one *United States*. The same principle applies to the "world market" and to the United Nations. Both are *one* entity that is inseparable from its *many* constitutive members.

The phenomenon of global warming is similar. It is one phenomenon that is inseparable from many factors. Figures 1-15 through 1-17 list, by nation, the many contributors to this one phenomenon. Although the contributors don't exactly stand in the same relation to the phenomenon of global warming as States do to the federal government of the USA, in that they are not parts or elements of it, the basic idea is still the same. The many comprise the one.

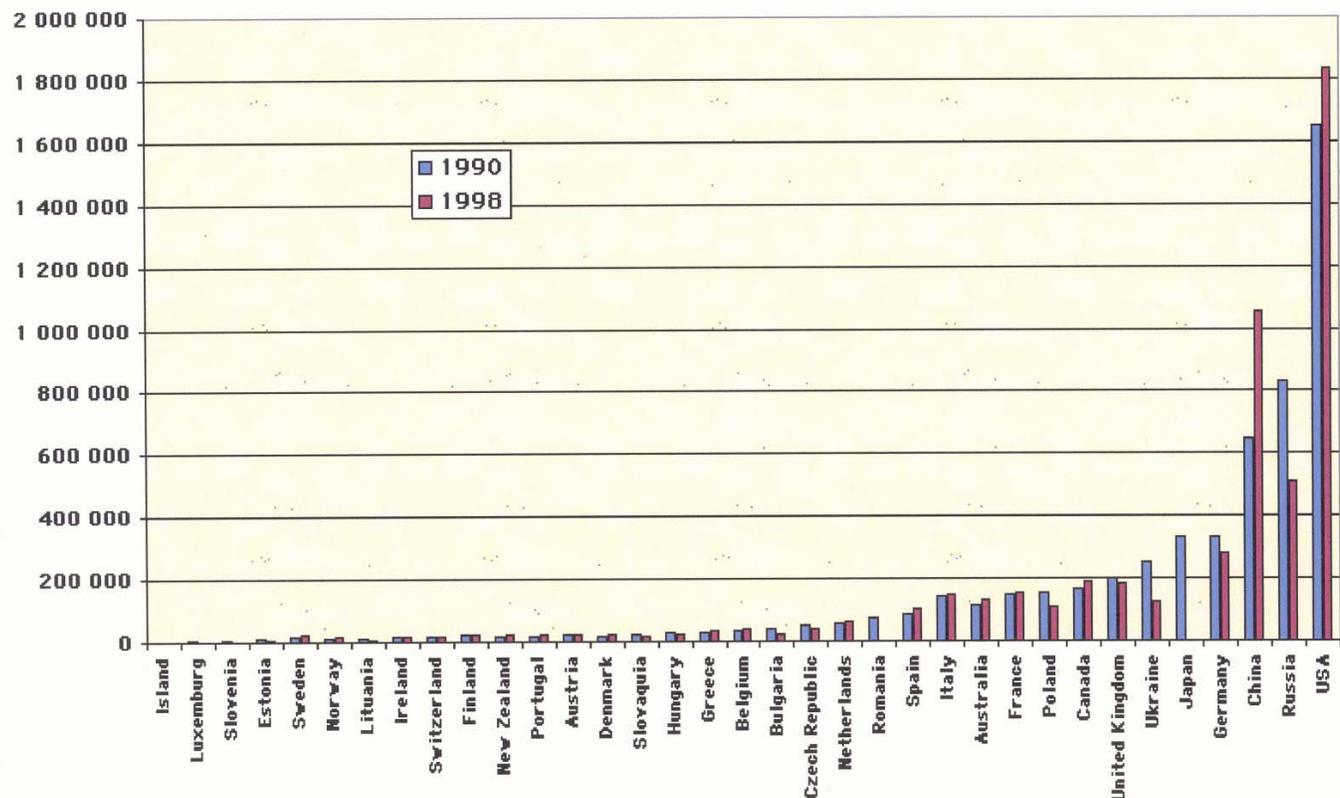


Figure 1-15. Greenhouse gas emissions per thousand tonnes carbon equivalent for most Annex I countries plus China. (Reprinted from <http://www.manicore.com>. Original source: United Nations Framework Convention on Climate Change (UNFCCC); for China emission concern CO2 only, figures coming from the French Ministere d'Industrie).

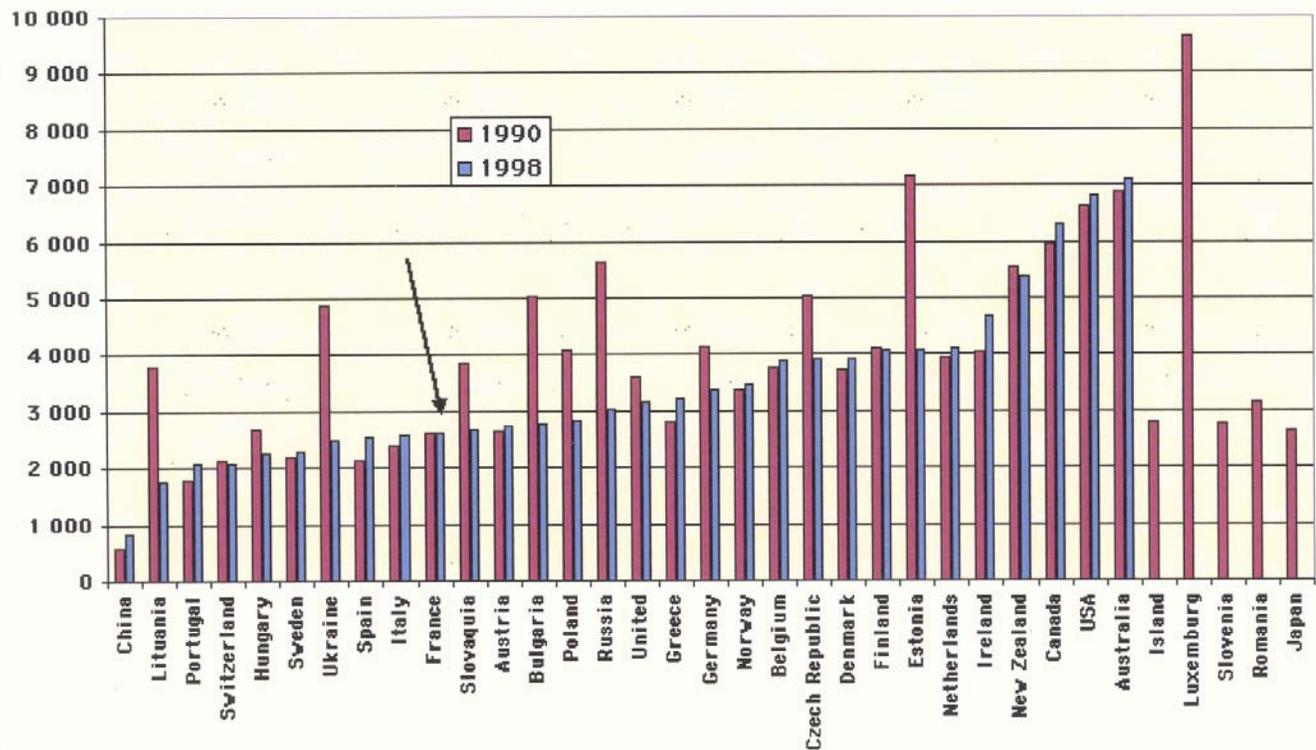


Figure 1-16. Greenhouse gas emissions per person, and per year, in kg carbon, for most Annex one countries plus China. France gets an arrow because they are a so called "virtuous" country, producing their electricity through carbon-free means. Also important is that emissions per inhabitant in China are close to one-tenth of that of the U.S. (Reprinted from <http://www.manicore.com>. Original Source: UNFCC, except China: French Ministere d'Industrie)

Country	Percentage Share of World Industrial CO ₂ Emissions, 1992	Percentage Share of World GDP, 1993	Percentage Share of World Population, 1993
United States	21.85	27.08	4.69
China	11.94	1.84	21.42
Russian Federation	9.41	1.43	2.70
Japan	4.89	18.23	2.26
Germany	3.93	8.27	1.47
India	3.44	0.98	16.33
United Kingdom	2.53	3.54	1.05
Canada	1.83	2.07	0.52
Italy	1.83	4.29	1.04
France	1.62	5.42	1.05
Poland	1.53	0.37	0.70
Mexico	1.49	1.49	1.64
Australia	1.20	1.25	0.32
Spain	1.00	2.07	0.72
Brazil	0.97	1.92	2.84
Indonesia	0.83	0.63	3.40
Netherlands	0.62	1.34	0.28
Czech Republic	0.61	0.14	0.19
Romania	0.55	0.11	0.41
Sweden	0.25	0.72	0.16

Figure 1-17. (Reprinted from Goulder and Nadreau, 2002, 119)

Figures 1-15 through 1-17 reveal the main culprit, though it should not be overlooked that other countries are complicit. Accounting for one-quarter of global CO₂ emissions, the United States has by far the highest emissions rate and one of the highest emissions rates per person. If citizens of China and India were fortunate enough to live like us, if their respective emissions per person were equivalent to that of the United States, the greenhouse problem would already be intractable. One-third of the United State's CO₂ emissions come from households, which means that 8.25% of global emissions come from households in the United States alone. More generally, if undeveloped countries emitted greenhouse gases at the same rate as developed countries, the problem would already be intractable. As we will see, one of the many flaws of the Kyoto protocol is that it does not apply to undeveloped countries. Even if developed countries decarbonize their energy sources, it does not follow that undeveloped countries will be able to follow suit. As the latter develop, they are more likely to use conventional, carbon-based, energy sources. Consider, in this respect, the following figures.

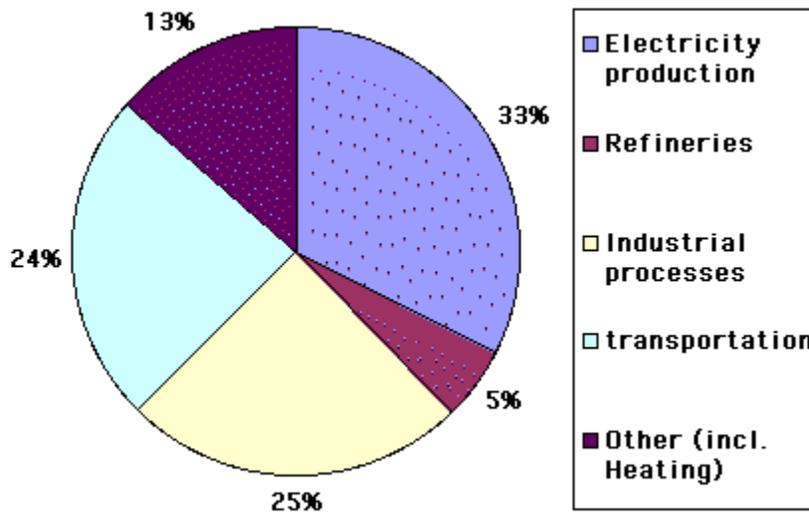


Figure 1-18. Breakdown of CO2 emissions in 1999. (Reprinted from <http://www.manicore.com>. Original source: International Energy Agency).

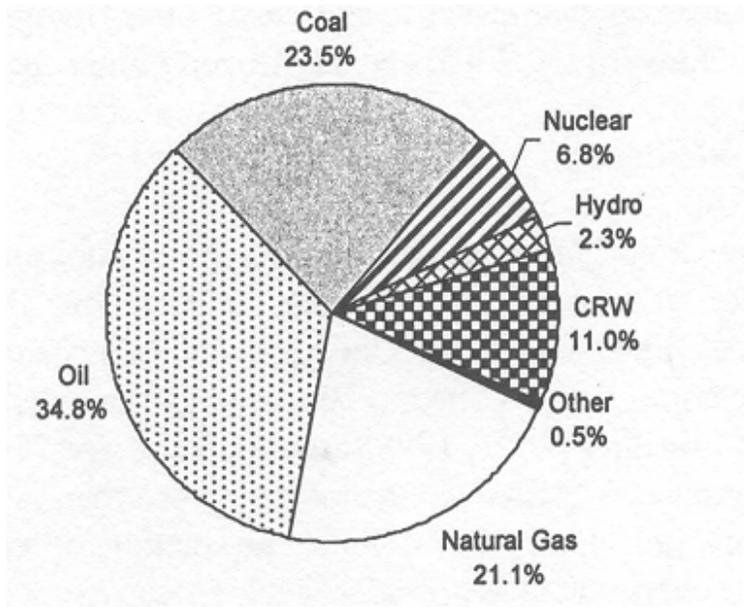


Figure 1-19. Contribution of many sources to global energy requirements in the year 2000. (Reprinted from Van Kooten, 2004, 65).

	Tonnes of carbon per million tonnes oil equivalent	Tonnes of carbon per 10 ¹² joules
Natural gas	0.61	13.8
Crude oil	0.84	19.0
Bituminous coals	1.09	24.5
Anthracites	1.14	15.5
Oil products		
Gasoline	0.80	18.0
Kerosene	0.82	18.5
Diesel/gas oil	0.84	19.0
Fuel oils	0.88	10.0

Figure 1-20. Carbon content of different fossil fuels. 1 barrel of oil = .136 tonnes calorie = 4.2 Joules (J); 1 British thermal unit (Btu) = 1.05 (kilojoules); 1 kilowatt-hour (kwh) = 3.6 J. Anthracite is a type of hard coal. (Reprinted from Van Kooten, 2004, 5).

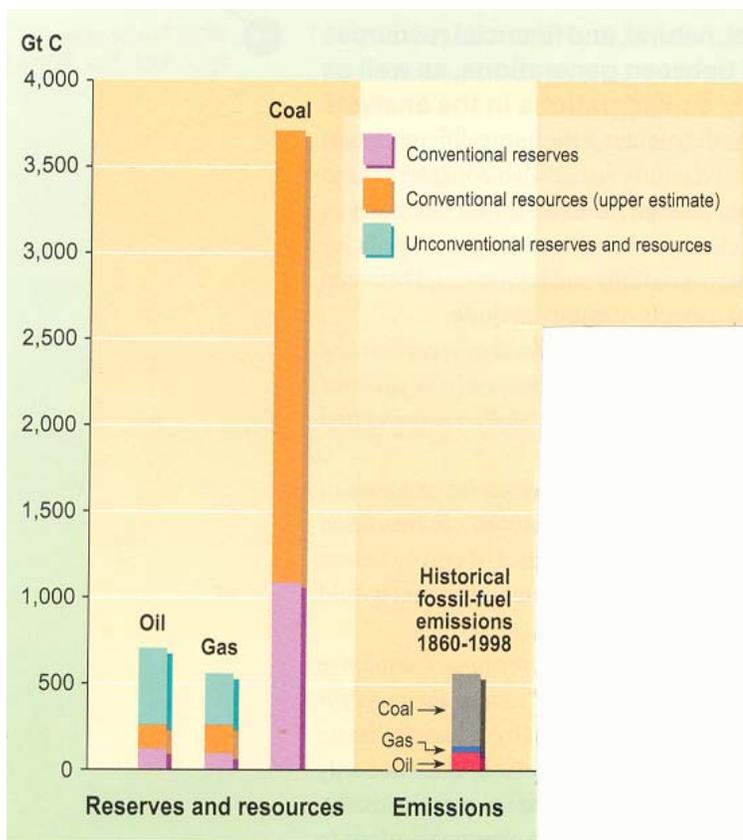


Figure 1-21. Carbon in oil, gas, and coal reserves and resources, compared with historical fossil fuel emissions over the period 1860-1998. (Reprinted from IPCC, 2001, 121)

Van Kooten concludes that "the CO₂ problem is *primarily* a coal problem" (5, my emphasis). Coal contributes 23.5% of global energy requirements, about 9% less than gas and oil, but as Figure 1-20 shows coal has an extremely high carbon content. Coal is by far responsible for the lion's share of historical fossil fuel emissions (Figure 1-21), though part of this is certainly due to the fact that coal was the only energy source available for the longest time. Of the 33% of global emissions from electricity production, it is reasonable to assume that most of this percentage came from coal. Coal accounts for 37% of CO₂ emissions in the United States. Also of note is that a full 5% of emissions come from refineries alone.

More disturbing still are the as yet untapped reserves of coal (Figure 1-21). Coal accounts for nearly 80% of all energy reserves. This leads Van Kooten to write, once again, that "a comparison of all known reserves in fossil fuels also makes it clear that climate change is *basically* a coal problem" (5, my emphasis). He goes on to cite the *The Economist*, whose projections are borne out by Figure 1-21: "if all known conventional oil and gas reserves (those in underground formations, obtained by drilling) were burned, the level of the CO₂ in the atmosphere would still be less than twice what it was before the beginning of the industrial revolution" (cited in Van Kooten, 2004, 5).

Add to this scenario the fact that 37.5% of the world's population lives in India and China, two developing countries sitting on top of huge coal reserves (IPCC, 2001, 321.) Coal currently provides about 70-80% of China's power. China's rising energy demands, brought about by increased industrialization, have recently resulted in a "coal-famine," leading to rolling blackouts and significantly decreased energy availability (*Parade Magaize*, 2-13-05, 23). China is working on installing a natural gas network, so

at least there is a bright prospect on the horizon. In the meantime, as these nations continue to develop they will certainly burn more coal.

On the other hand, as shown by Figure 1-18, there are other major sources of CO₂ emissions. If we had a silver bullet to use against greenhouse warming our best bet would be to fire through the heart of King Coal. By this I mean that burning coal for energy should be phased out in the most reasonable way possible, as part of a general strategy for decarbonization (see the policy options in "Ground" for more on this). Getting such a program underway will inevitably require working with or around King Coal's massive political influence, as well as making sufficient allowances for displaced workers. To sum up, great strides in mitigating greenhouse warming can be taken by targeting four major areas: (1) coal; (2) tropical deforestation, "roughly one-quarter of world greenhouse emissions...come from tropical deforestation" (Victor, 2004, 29); (3) improving energy efficiency in America; (4) improving energy efficiency in the transportation sector. All this is, of course, much easier said than done. But we have to diagnose the problem in order to form a plan of action.

As we can see, a major barrier to internalizing the greenhouse externality is that this *one* phenomenon can be affected only by changing its *many* sources. The nature of the barrier is such that emissions must be reduced by way of small percentages in disparate areas -- transportation, heating, agriculture, electricity, refineries, oil consumption, to name but a few. This is exactly Hegel's point in the section on "The One and the Many." Large-scale changes in the one self-enclosed system are the result of changes in the many smaller (finite) ones because the relations among the many ones comprise the one system.

This has been the course of action so far, though it has yet to be a coordinated course of action. For all the gloom and doom I depicted above, many efforts are being made by companies, firms, and state governments to address climate change. In the debate on the McCain-Lieberman "Climate Stewardship Act" Senator Akaka of Hawaii reports that

Four U.S. corporations are already taking the lead in reducing greenhouse gas emissions. BP, British Petroleum, the largest oil and gas producer in the U.S., and Dupont, a \$24 billion a year corporation...have already taken on emissions reduction strategies. Both BP and Dupont have claimed to save millions of dollars in the process. Cinergy, the largest burner of coal in the U.S., has pledged to reduce its greenhouse gas emissions by 5 percent with the belief that they can meet this target at no additional cost to the company or taxpayers. American Electric Power, the largest emitter of carbon dioxide in the U.S., has joined the Chicago Climate Exchange. This marketplace trades greenhouse gas emissions with a target of reducing emissions. The Governors of ten northeastern States developed a regional greenhouse gas trading program because of the lack of National leadership on climate change. Their program requires a mandatory cap on power plants in July of this year. In total carbon reduction, initiatives are already underway in 27 states (available at <http://www.congress.gov>).

Barry Rabe, in his *Statehouse and Greenhouse: The Emerging Politics of American Climate Change Policy*, documents the efforts of some of the twenty-seven states mentioned by Senator Akaka. Most of these efforts are the result of a handful of dedicated and quite clever state officials who have figured out how to implement climate change policies under the radar. All in all, "in 2002, 228 American firms claimed that they achieved reductions totaling 265 million metric tons of CO₂ equivalents (about 4 percent of actual gross U.S. emissions that year)" (Victor, 2004, 27). There are many independent efforts under way to internalize the greenhouse externality. Indeed, one can confidently say that the tide is turning. But as yet there is no coordinated effort that could affect in any significant way the system of relations that will mitigate or exacerbate global warming. Then again, the relational nature of the issue is such that every little bit helps.

Repulsion and Attraction

Putting the problem of climate change in Hegelian terms, we could state that there is no coordinated system of relations among the many finite ones that contribute to the one phenomenon of global warming. In exactly the same manner, we left the *Science of Logic* proper with many finite ones, individual atoms or particles, floating in the infinite void (the one one). Hegel must now establish in greater detail relations among these ones. These relations are repulsion and attraction.

Repulsion and attraction were popular scientific explanatory categories in Hegel's time. So Hegel was especially eager to make this concept a moment of his dialectic. We will see that Hegel *et al* were right about repulsion and attraction, but for the wrong reasons.

In his alacrity to make repulsion and attraction a moment of the *Logic*, Hegel lays the dialectical language on thick.

But we have also to see what is posited in them [the many ones] in their *inter-relatedness*. *They are* -- this is presupposed in their inter-relatedness -- and they *are* only in so far as they reciprocally negate one another and at the same time hold themselves aloof from this their ideality, their negatedness, that is, negate this reciprocal negating. But they *are* only in so far as they negate... (171).

In so far as the many ones negate each other they are repulsed by one another. In so far as the many ones negate this negation, they are attracted to one another. Here we encounter one of Hegel's neat dialectical tricks. The many ones are all exactly *the same* (they are all ones) in that each one of them excludes all the other ones. Further, the many ones are attracted to one another in so far as they repulse one another, and vice versa -- "attraction is inseparable from repulsion" (173). As Stace states, "repulsion merely means that the many ones exclude one another. Attraction merely means that they are at the same time identical [because each excludes all others]. Repulsion is the mutual

exclusion of the ones by each other, whereby they emphasize their *difference*. Attraction is their mutual inclusion and *identity* (1955, 153)."

If the many ones were only attracted to one another, there would not be many ones but only a huge undifferentiated lump of matter. If the many ones only repulsed one another, the universe would fall apart at the seams because the ones could not relate to each other. So attraction is inseparable from repulsion.

Brian Greene demonstrates this notion in a thought experiment:

[I]magine holding an electron in your left hand and another electron in your right hand and bringing these two identical electrically charged particles close together. Their mutual gravitational attraction will favor their getting close together while their electromagnetic repulsion will drive them apart. Which is stronger? There is no contest: The electromagnetic repulsion is about a million billion billion billion billion times stronger!... The only reason the electromagnetic force does not completely overwhelm gravity in the world around us is that most things are composed of an equal amount of positive and negative electrical charges [attraction and repulsion] whose forces cancel things out (1999, 12).

Greene goes on to explain:

[T]he universe would be a vastly different place if the properties of matter and force particles were even moderately changed. For example, the existence of the stable nuclei forming the hundred or so elements of the periodic table hinges delicately between the strengths of the strong and electromagnetic forces. The protons crammed together in atomic nuclei all repel one another electromagnetically; the strong [attractive] force among their constituent quarks, thankfully, overcomes this repulsion and tethers the protons tightly together. But a rather small change in the relative strengths of these two forces would easily disrupt the balance between them, and would cause most atomic nuclei to disintegrate (12-13).

Greene gives several more examples of how the balance between attraction and repulsion holds the universe together. The merit of Hegel's account is that he established a firm dialectical relation between attraction and repulsion, which was later borne out by empirical evidence. We now turn to how this relation, or inter-connectedness, between the one and the many is further developed through quantum or, more specifically, numbers.

Magnitude (Quantity)

Hegel offers the following definition of quantity: "quantity is the determinateness *which has become indifferent to being* [my emphasis], a limit which is just as much no limit, being-for-self which is absolutely identical with being-for-other -- a repulsion of the many ones which is directly the non-repulsion, the continuity of them" (185). Three points should be noted from the start. The first is that quantity is indifferent to what it is a quantity of. 5,000, for example, can refer to the number of termites in my house, to the number of bombs dropped in a war on one day, or to the number of alien spacecraft poised to take over earth. The second point is that quantity is governed by attraction and repulsion. $5 = 1+1+1+1+1$. Each 1 repulses, or is separate from, the others; yet each one is attracted to, or continuous with, the other ones in the number 5. Third, quantity is a limit which is no limit -- 5 is the limit of $1+1+1+1+1$, but it is always possible to exceed this limit, in the form of 6, by adding another 1. The being-for-self of five is identical with its being-for-other because 5 is 5 (being-for-self) only because it is flanked by 4 and 6 (being-for-other). The same is applicable to any quantum or number. Now we shall tie these three points together.

Pure Quantity

Quantum should be distinguished from pure quantity. Quantum is a determinate quantity, such as 100 miles, or 2 degrees, or 6 roaches (185). Pure quantity is an indeterminate quantity that has yet to be carved up into determinate quanta. Space, for example, is a pure quantity. It is not necessarily infinite, but as our example from infinity showed it is indefinitely extended. When we carve out a definite amount of space, such as 100 miles, this is a quantum. Or again, there are not an infinite number of people in

the world. But there is an indefinite number of people in the world. Carve, say, 2.4 billion out of this quantity and we have a definite quantum (see Stace, 157).

Continuous and Discrete Magnitude, Limitation of Quantity

Quantity is a matter of the various combinations of many ones in so far as they are governed by attraction and repulsion. In the section on "Pure Quantity," Hegel writes: "The Absolute brittleness of the repelling *one* [the one excluding all other ones] has melted away into this *unity* which, however, as containing this one, is at the same time determined by the immanent repulsion, and as unity of the self-externality is unity with itself. Attraction is in this way the moment of *continuity* in quantity" (186). Insofar as the ones are identical, attraction joins them together, proceeding in a continuum from $1+1+1 = 3$. Insofar as the ones are discrete, repulsion separates each one from the others. Thus continuity "is only [a] coherent, compact unity as unity of the discrete" (199).

Just like attraction and repulsion, continuous and discrete magnitude are inextricably intertwined. "Because discrete magnitude is quantity, its discreteness is itself continuous" (200). $1+1+1$ would not even be three discrete 1's if they were not combined into a unity, or continuity, of 3. "This continuity in the discrete consists in the ones being the same as one another, or in having the same *unity*. Discrete magnitude is, therefore, the asunderness of the manifold one [the one one is now what all the ones are] as self-same, not the manifold one in general [not the infinite one of the void, or the one one] but posited as the *many of a unity* [the many ones of, say, the unity of three]" (200). This point brings to fruition dialectical development that started in infinity. The infinite became "the one one," as contrasted with the many ones. The infinite then became the

Number

"[N]umber appears as discrete magnitude, but in the unity it equally possesses continuity" (203). Hegel then makes one of the first distinctions between quantity and quality.

...the breaking off [in the counting] of the many ones and the exclusion of the other ones appears as a determination falling outside the enclosed ones. But in the qualitative sphere it was found that the limit pervades the determinate being, is coextensive with it, and consequently that it lies in the nature of something to be limited, that is, finite (203).

If you break off counting at, say, 100, then you have enclosed, or limited, 100 ones. Yet there are n number of ones *outside* of this limitation of the continuum of ones. The qualitatively finite, on the other hand, has its limitation *inside* it in that the relations which constitute something qualitatively finite are **in** it.

...say a hundred is conceived in such a manner that the hundredth one alone limits the many to make them a hundred. In one sense this is correct; but on the other hand none of the hundred ones has precedence over any other, for they are only equal -- each is equally the hundredth; thus they all belong to the limit which makes the number a hundred and the number cannot dispense with any of them for its determinateness. Hence, relatively to the hundredth one, the others do not constitute a determinate being that is in any way different from the limit, whether they are outside or inside it. Consequently, the number... constitutes this limitation which is a specific quantum; the many constitute a number, a two, a ten, a hundred, and so on (203-204).

For Hegel, numbers are intrinsically dissatisfying. Relations among numbers splay out all over the place. Sure, you can limit a hundred ones. But what about all the other numbers not contained in these hundred ones? How are they related to what you have limited? Moreover, the connection of numbers with reality is extrinsic at best, and arbitrary at worst. Numbers mostly relate only to each other, and don't even do that very well. They can be indifferently manipulated and rearranged in any which way. "Number has for its principle the one and is, therefore, simply an aggregate put together, a purely analytic figure devoid of any inner-connectedness" (205). "Seeing that the limit is an

external one, the breaking off of the counting, the amount to be aggregated, is contingent, arbitrary (206).

Hegel's criticisms become even sharper. His criticisms are equally applicable to quantitative, or economic, analysis of climate change, so we should pay careful attention to what Hegel is saying. There has been no dearth of quantitative analyses of climate change. What one commentator writes of the political process involving climate change is also true of its economic analysis: "the political process has been an oasis for goal setters yet a desert of action" (Victor, 2001, 1990). Part of the problem is that economic projections are just a bunch a numbers; numbers which have no intrinsic connection with the situation on the ground. Hegel maintains that "when numbers are supposed to represent *concrete* relationships, it is vain to try to retain such resemblance" (215).

Number is a non-sensuous object, and occupation with it is non-sensuous business; in it mind is held to communing with itself and to an inner abstract labor, a manner of great though one-sided importance. For, on the one hand, since the basis of number is only an external, thoughtless difference, such occupation is an unthinking, mechanical one (216).

"A matter of great though one-sided importance." Such is the proper characterization of quantitative analyses of climate change. It is of great importance because only a feasible economic plan will help mitigate emissions. Economic analysis is merely one-sided in that economists working on global climate change seem to be beholden to only one god -- Numbers. Economists get so wrapped up in their numbers that they tend to forget that theirs is a *non-sensuous* business. In an ideal world, economic analyses are never an end in themselves; they are a means for fulfilling something like moral principle (2). Thus paying lip service to the neo-classical idea of "maximizing welfare for the greatest number" or "maximizing the discount value of utility obtained from the consumption of a

consumer good" are not exactly sufficient. Economists tend to forget that "maximizing welfare" does not always occur by throwing money at a problem.

In addition, the *economic* assessment of welfare is an unreliable means of assessment. For instance, Victor observes that "poor nations that are less able to adapt are likely to suffer more greatly from climate change. However, wage levels are lower in these societies, which typically reduces the economic cost of lost life and health, thus lowering the estimated consequences of climate change. "Similar results occur when the stress of heat is assessed," as in the 2003 European heatwave, "elderly populations suffer more than the young, but the elderly have fewer economically productive years left to lose" (2004, 16).

Consider, in this regard, Tol's climate impact model. "The impact module has two units of measurement: people and money. People can die prematurely and migrate. These effects, like all other impacts, are monetized" (2003, 272). Also monetized are "cardiovascular and respiratory diseases," the impacts of climate change "on coastal zones, forestry, unmanaged ecosystems, water resources, malaria, dengue fever, and schistosomiasis" (272). My point is that you can't put a price-tag on environmental degradation, human suffering and death, and losing other animal species; or at least these things cannot be *reduced to* their mere economic impact. In Figure 1-22, species loss, forest loss, and human mortality and morbidity are projected by five different economic models.

	Cline (2.5°C)	Fankhauser (2.5°C)	Nordhaus (3°C)	Titus (4°C)	Tol (2.5°C)	
Agriculture	17.5	3.4	1.1	1.2	10.0	
Forest loss	3.3	0.7	(a)	43.6	(a)	
Species loss	4.0	1.4	(a)	(a)	5.0	
Sea level rise	7.0	9.0	12.2	5.7	8.5	
Electricity	11.2	7.9	1.1	5.6	(a)	
Nonelectric heating	-1.3	(a)	(a)	(a)	(a)	
Mobile air conditioning	(a)	(a)	(a)	2.5	(a)	
Human amenity	(a)	(a)	} 0.75% of GDP	(a)	12.0	
Human mortality and morbidity	5.8	11.4		9.4	37.4	
Migration	0.5	0.6		(a)	1.0	
Hurricanes	0.8	0.2		(a)	0.3	
Leisure activities	1.7	(a)		(a)	(a)	
Water supply						
Availability	7.0	15.6			11.4	(a)
Pollution	(a)	(a)			32.6	(a)
Urban infrastructure	0.1	(a)			(a)	(a)
Air pollution	3.5	7.3			27.2	(a)
Total						
Billions	61.1	69.5	55.5	139.2	74.2	
Percent of GDP	1.1	1.3	1	2.5	1.5	

Figure 1-22. (Reprinted from Nordhaus and Boyer, 2000, 70). Numbers are for the United States, in billions of 1990 U.S. dollars.

Thomas *et al* state in the journal *Nature* that "we predict, on the basis of mid-range climate-warming scenarios for 2050, that 15-37% of species in our sample region will be committed to extinction" (2004, 145). This number is staggering; perhaps one-third of all species on earth could go extinct as a result of climate change. And that is a short-term prediction for 2050. Clearly, the estimates, economic and otherwise, in Figure 1-22 are grossly understated. Should we prevent species loss because animals need not suffer and die unnecessarily and because biodiversity is intrinsically valuable, or should we prevent it because it is economically damaging? Should we try to prevent human mortality and morbidity because it may cost 37.4 billion dollars? Or should we try to prevent it

because human beings ought not to suffer and die unnecessarily? The answer is, obviously, both.

As long as the end is achieved, the motivation for achieving it is of little consequence. If one's motivation for mitigating climate change is purely economic, so be it. The economic damages of climate change could be quite substantial, and that translates into people suffering unnecessarily.

In the long run, it will probably be cheaper to pay a lump sum in front to prevent further climate change than to pay for the damages caused by climate change. The sticking point, of course, is the uneven and uncertain distribution of damages caused by climate change. Thus some countries are not willing or able to pay to prevent future damages. Such are the unruly relations between the many ones that constitute the system of relations that will exacerbate or mitigate climate change.

So despite Hegel's suspicions and my own little diatribe about numbers and quantitative analysis, it is absolutely imperative that we crunch the numbers and come up with a cost-effective way of mitigating climate change. In the moral principle that human beings and other animals ought not to suffer unnecessarily, when unnecessarily means that "reasonable measures" can be taken to prevent such suffering and death, the reasonable measures are political and economic policies that can be arrived at only by crunching the numbers. An inefficient economic policy for dealing with climate change could possibly cause more damage, and therefore more suffering, than it is meant to prevent. I will give a more detailed quantitative analysis of climate change at the end of the section on ratio. In the chapter on Measure we will see how quantity is found in material reality in a non-arbitrary form.

rather than its plurality. In other words, it emphasizes the Limit...Intensive quantum is thus the more developed idea of the two" (54). Hegel expresses the superiority of intensive over extensive quantum in the transition from amount to degree. Degree is "quantum posited as unitary." "The degree is thus a specific magnitude, a quantum; but at the same time it is not [like amount] an aggregate or plural *within itself*; it is a plurality only in principle" (218). Degree, again, is a concentration of many ones. "When we speak of ten or twenty degrees, the quantum that has a number of degrees is the tenth or twentieth degree, not the amount and sum of them -- as such, it would be an extensive quantum -- but it is only *one* degree, the tenth or the twentieth" (218).

The difference between the unified concentration of number (degree, intensive magnitude) and the aggregate of a sum of numbers (amount, extensive magnitude) is admittedly fine-grained. "Extensive and intensive magnitude are thus one and the same determinateness of quantum; they are only distinguished by the one having amount within itself and the other having amount outside itself" (220). This distinction is important because it contains the germ of the *qualitative* aspect of quantity, particularly with regard to intensive magnitude. The concentration of twenty ones in twenty is the quality of twenty. This germ must now be further developed.

Alteration of Quantum

As the title of this section suggests, the problem with quantum, with numbers, is that they won't hold still. As I previously remarked, the relations between numbers splay out in all sorts of directions. "In extensive magnitude this difference [between extensive and intensive quantum] is developed; but intensive magnitude is the *existence* of this

externality which quantum is within itself. This difference, as internally self-contradictory, is posited as having...its determinateness not within itself but in another quantum" (225, original emphasis). In other words, 20 is 20 only because it is flanked by 19 and 21. Likewise, 21 is 21 only because it is flanked by 20 and 22. "A quantum, therefore, in accordance with its quality, is posited with its externality, with its otherness...The quantitative determinateness continues within itself into its otherness in such a manner that the determination *has its being only in this continuity with an other*" (225, my emphasis). Again, 20 automatically implies 19 and 21; 19 and 21 automatically entail 18 and 20, and 20 and 22; 18 and 20, and 20 and 22 automatically entail 17 and 19, 19 and 21, and 21 and 23; these numbers automatically entail...and so on to infinity.

Thus quantum impels itself beyond itself; *this other which it becomes is in the first place itself a quantum* [my emphasis]; but it is quantum as a limit which does not stay, but which impels itself beyond itself. The limit which again arises in this beyond is, therefore, one which simply sublates itself again and impels itself beyond to a further limit, *and so on to infinity* (225).

Quantative Infinity

The quantitative version of spurious infinity is easy to grasp. No matter how high you count you can always add another number. Quantitative infinity takes on the form of $n + 1$. Now "the difference between qualitative and quantitative infinity is that in the former the finite and infinite are *qualitatively* opposed" (226). That is, the qualitatively finite and infinite were seen as two *separate, mutually exclusive*, things. Hegel showed, however, that the finite and infinite actually entail one another. He takes the same tack with quantitative infinity, and the beauty of his refutation of the spurious quantitative infinite lies in its simplicity.

In quantitative infinite progress, n represents a finite quantum or limit, say the highest you are able to count, and $+1$ represents the infinite numbers lying beyond n , which will always remain no matter how high you count. According to Hegel, this shows that the infinite beyond of quantum is merely another quantum. Just as with qualitative finitude and infinity, the quantitatively finite and infinite are separate -- they are joined together in that both are numbers. Thus quantity is self-related in its infinity. Since, as the example above shows, quantum always continues itself into its externality, into another quantum, "quantum is continuous with its beyond; quantum consists precisely in being the other of itself, in being external to itself; this externality is, therefore, *no more an other than quantum itself* [my emphasis]; the *beyond* or the infinite is, therefore, itself *a quantum*. In this way, the beyond is recalled from its flight and the [true] infinite is attained" (227).

The infinite of quantum is not a non-quantum, or the non-being of quantum. The quantitatively infinite must be yet another number if it is to be *quantitatively* infinite.

Thus the quantitative infinite is the same as the quantitative finite in that both are quanta.

This its self-externality is in the first place the *abstract non-being* of quantum generally, the spurious infinity. But, further, this non-being is also quantitative and continues itself into its non-being, for it is in its externality that quantum has determinateness; this its externality is, therefore, itself equally a quantum; this non-being of quantum, infinity, is thus *limited*, [my emphasis] that is, this beyond is sublated, is itself determined as quantum which, therefore, in its negation is with itself (238).

Finally, in, of all things, infinity, quantum obtains true limitation.

Hegel uses the misguided notions of infinitely great and infinitely small to illustrate this point. The former involves the Hebrew definition of God as greater than the greatest mountain, or even the medieval idea of God as perfect, which Descartes also employs. Perfection is that to which nothing greater can be added. By definition,

quantum can be increased or diminished. So there can be no such thing as the mathematical infinite or God as infinitely perfect. "Now since the infinitely great or small is that which cannot be increased or diminished, it is in fact no longer a quantum as such...for quantum [in the infinitely great] in so far as it is infinite is required to be thought as sublated, as something which is not quantum but yet retains its quantitative character" (243). Infinitely great or infinitely perfect is an oxymoron since this sort of infinity cannot be quantitative.

Ratio

In quantitative infinity quantum "continues itself into the beyond; this [the beyond], in the first place, is simply *another* quantum" (314). Quantitative infinity is a relation between two quanta. So it is the *quality* of quantum. "The quality of quantum, the specific nature of its Notion, is its externality as such [that it always relates to other numbers], and in ratio the quantum is now *posited* as having its determinateness in its externality, in another quantum, and as being in its beyond what it is." Ratio is the relation between two numbers; that is, the self-relation of quantum. And this entails the quality of quantum -- for example, $3:6 = 2$. So again, the self-relation of quantum is qualitative.

The only redeeming quality of quantum *is* its quality. After summarizing how quantum's self-relation is qualitative, we will turn to the ratios of climate change. In particular, we will turn to that self-relation of quantum known as cost-benefit ratios, and examine in some detail the qualitative results of Nordhaus and Boyer's quantitative analysis of climate change.

In direct ratio, the related quanta, such as 2:4, are logically prior to their exponent, .5, which "is simple determinateness as the qualitative moment of the sides of the ratio" (316). But the related quanta are incomplete without their exponent or their qualitative moment, so the logical priority temporarily flip-flops. In inverse ratio the exponent takes priority, yet this soon reveals that the related quanta and the exponent are all bound up in a whole. In inverse ratio, say $.5 = 2:4$, if 2 is raised to 3 then 4 must be raised to 6. While it is true that .5 can be expressed by an infinite number of numbers, its limit is not an infinite beyond. Only a limited number of numbers, in a certain combination, equal .5. "The whole, as exponent, is the limit of reciprocal limiting of both terms [of the ratio] and is therefore posited as *negation of negation*, hence as infinity, as an affirmative relation to itself" (320). 2:4, 3:6, 100:200, and so on are "the identification of the exponent [.5] with itself in its *self-external otherness*" (321). The exponent .5 cannot be changed without altering the ratio. By the same token, within certain limits the ratio cannot be changed without altering the exponent. Hegel invokes infinity in the passage above, then, because all three aspects of ratio are mutually related. Just as in the feedback loop of infinity, all the components of ratio affect one another.

The ratio of powers embodies such a qualitative relation. .5 is simply 2:4 in its otherness; and 2:4 is simply .5 in its otherness. Hegel means something like this in claiming that the components of ratio are "posited as negation of negation." If one component is altered, then the other components are also altered. Therefore, ratio is a *qualitative relation*. As we saw above, repeatedly, *since what something is is comprised of relations, altering that to which something is related alters that something*. Such is exactly the case with ratio. When the relations that comprise the whole change so does

the whole. One more time: Large-scale changes in the self-enclosed system (the whole) are the result of changes in the many components because the relations among the many components comprise the system

We have come full circle. "At first, then, quantity as such appears in opposition to quality; but quantity is itself *a* quality, a purely self-related determinateness...But quantity is not only *a* quality; it is the truth of quality itself, the latter having exhibited its own transition into quantity" (323). "Quantum *is now no longer an indifferent or external determination* [which sparked Hegel's criticism and my diatribe above], but as such is sublated and is quality, *and is that by virtue of which something is what it is* (323-324, my emphasis). We shall now turn to how this qualitative quantum is played out in cost benefit analysis of climate change. In the subsequent chapter on Measure, Hegel makes good on the claim that quantum is "that by virtue of which something is what it is."

Quantitative Analyses of Climate Change

I want to emphasize three points in examining quantitative analyses of climate change. The first is that the Kyoto Protocol is not a "reasonable measure," as I have defined the term, for dealing with climate change. The second is that a cap and trade system, in which companies are assigned emissions permits and may exceed their emissions allowance through trading permits with other companies, coupled with a world carbon tax or a "safety-valve" measure *borders on* being a reasonable measure. Its primary drawback is, third, that at present it is difficult to see how such measures could be implemented, given the unruly relations between the many countries responsible for

greenhouse warming. We will first examine Nordhaus and Boyer's *Warming the World: Economic Models of Global Warming*. It should be borne in mind that their models are a few of countless economic models to emerge in the last few years. We will then turn to a report by Smith and Bernstein on the *Impacts of Implementing a Carbon Cap with a Safety Valve on Allowance Prices*. The relation of this analysis of climate change to what we have been considering in Hegel is that we are analyzing the qualitative feature of quantity, specifically in the form of a ratio -- cost/benefit.

Here is a description of the different policies analyzed in Nordhaus and Boyer's economic models.

No Controls (Baseline) : This is the scenario that has been followed so far. It is also the one to which we referred above. No policies are taken to slow or reverse greenhouse warming. "Individuals and firms would adapt to the changing climate, but governments are assumed to take no steps to curb greenhouse-gas emissions or to internalize the greenhouse externality" (2000, 123).

Optimal Policy: The second case is a designed economically efficient policy to slow climate change. This "run finds a Pareto optimal trajectory for the world carbon tax (and thus for global industrial emissions), one that balances current abatement costs against future environmental benefits of carbon abatement" (123). A "Pareto-optimal policy" sets "the carbon tax in each region equal to the global environmental shadow price of carbon. The environmental shadow price of carbon is the impact through environmental channels of a unit of emissions today on the present value of consumption in all regions of all future periods" (25). The Pareto-optimal policy is designed to redress the fact that

some regions "are likely to be more affected by climate change, and the costs of an efficient policy are also likely to be quite asymmetric. The allocation of carbon permits within a trading bloc is a way of influencing the distribution of gains and losses from climate-change policy" (25). In other words, this policy is a way of economically evening things out. The optimal policy is "provided as a benchmark for policies to determine how efficient or inefficient alternative approaches may be." It is not presented "in the belief that an environmental pope will suddenly appear and provide infallible canons of policy that will be scrupulously followed by all" (123).

Ten-Year Delay of Optimal Policy: In this case nations delay implementing the optimal policy for ten years. Such a delay might, for instance, allow nations to calculate the costs and benefits of implementing policies until knowledge about global warming is more secure.

The Kyoto Protocol: The Kyoto Protocol of December 1997 is designed to limit the emissions of Annex I countries -- essentially, most economically developed countries plus Eastern Europe and most of the former Soviet Union. The Protocol states: "The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide emissions of the greenhouse gases...do not exceed their assigned amounts, ...with a view to reducing their overall emissions of such gases by at least 5 percent below 1990 levels in the commitment period 2008-2012" (214). In short, Annex I countries must reduce their combined emissions of greenhouse gases by 5 percent relative to 1990 levels. The present model assumes that Annex I emissions limits

continue indefinitely (dubbed "Kyoto forever"); that there is trading of emissions rights among Annex I countries; and that Annex I countries are allocated emissions permits as specified in the Protocol.

Stabilizing Global Emissions: This policy broadens the Kyoto Protocol to include all countries, stabilizing their emissions at 1990 levels. Kyoto targets only the emissions of high-income countries. This policy is therefore more stringent than Kyoto given that Kyoto does not limit the emissions of developing countries such as India and China.

Concentrations Stabilization: This approach limits CO₂ concentrations to two times their industrial levels, with a threshold of 560 parts per million of CO₂, or about 1190 GtC in the atmosphere. This policy also solves for the Pareto optimal carbon tax trajectory, as the tax is subject to the constraint of 1190 GtC in the atmosphere.

Climate Stabilization: On this scenario the global mean temperature rise is limited to 2.5 degrees C. "This is the IPCC's central estimate for the equilibrium temperature increase associated with a doubling of the atmospheric carbon dioxide" (126). Nordhaus and Boyer limit the temperature increase to 1.5 degrees C. In both cases, they "solve for a cost minimizing emissions trajectory subject to temperature remaining below the limit" and "assume that the plan is implemented through harmonized carbon taxes or a revenue-neutral permit allocation" (126).

The definition of the *net economic impact* of a policy "is the sum across regions of the present value of consumption under that policy minus the present value of consumption in the base case" (127). *Abatement costs* "are defined as the difference between the present value of consumption in the base case and the present value of consumption under the policy assuming that the policy does not have any effect on the path of global mean temperature. The *environmental benefits* of the policy are then the sum of the abatement costs and the net economic impact" (129, my emphasis).

Nordhaus and Boyer's use "easily" reproducible computer programs called RICE-99 and DICE-99 to obtain the following results.

	RICE-99	DICE-99	Old Dice
<i>Base</i>	0	0	0
<i>Optimal</i>			
Policy in 1995	198	254	283
Policy in 2005	192	246	254
<i>Limit emissions</i>			
Global stabilization	-3,021	-5,705	-7,394
Kyoto Protocol (a)	-120	na	na
<i>Limit concentrations</i>			
Double CO ₂	-684	-1,890	na
<i>Limit temperature</i>			
2.5 degree increase	-2,414	-4,396	na
1.5 degree increase	-26,555	-20,931	-42,867

Figure 1-23. Net economic impact (billions of 1990 U.S. dollars). Implemented by assuming that damages from climate change are zero. (a) Annex I trading (Reprinted from Nordhaus and Boyer, 128)

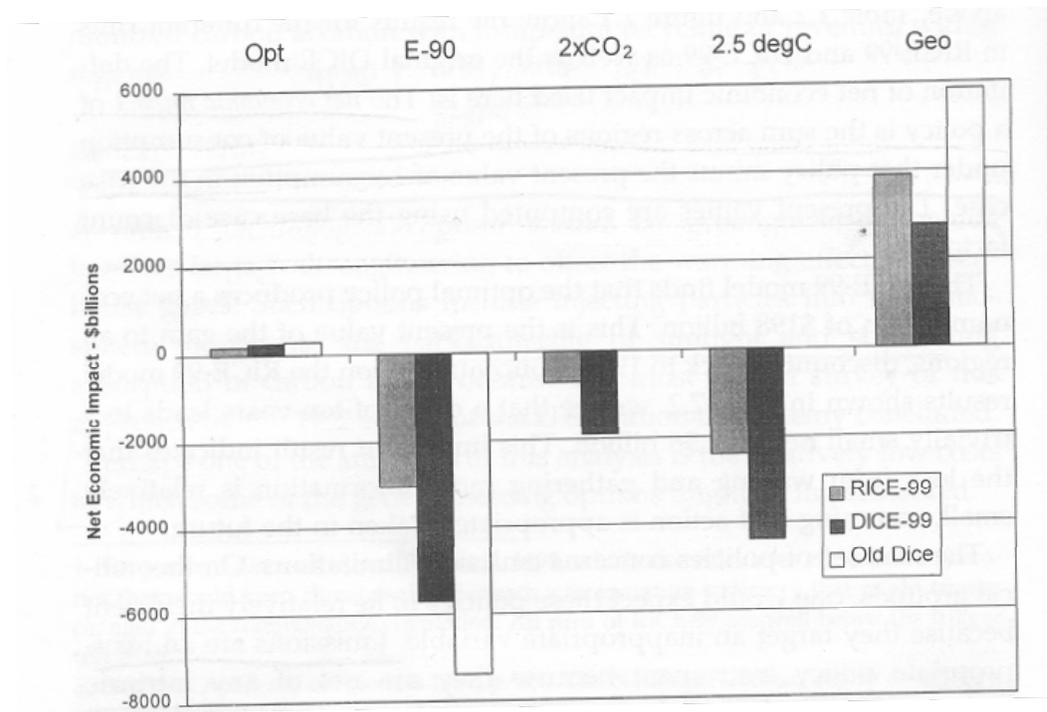


Figure 1-24. Global net economic impact -- \$ billions. Geo is geo-engineering, not discussed. E-90 is stabilizing global emissions (Nordhaus and Boyer, 128).

	Abatement cost	Environmental benefit	Net economic impact	Benefit/cost ratio
<i>Base</i>	0	0	0	na
<i>Optimal</i>				
Policy in 1995	-98	296	198	3.02
Policy in 2005	-92	283	192	3.08
<i>Limit emissions</i>				
Global stabilization	-4,533	1,512	-3,021	0.33
Kyoto Protocol	-217	96	-120	0.44
<i>Limit concentrations</i>				
Double CO ₂	-1,365	681	-684	0.50
<i>Limit temperature</i>				
2.5 degree increase	-3,553	1,139	-2,414	0.32
1.5 degree increase	-28,939	2,383	-26,556	0.08

Figure 1-25. Abatement costs and environmental benefits of different policies (billions of 1990 U.S. dollars). (Nordhaus and Boyer, 130).

The benefit-cost ratios shown in the last column in Figure 1-25 demonstrate that only the optimal plan passes the cost-benefit test, with a benefit-cost ratio of 3.08. The inefficient plans have benefit-cost ratios ranging from .08 to .5. Here we can see Hegel's general point of how a quantitative analysis yields qualitative results. Based on the numbers, the only qualitatively desirable policy is the "Optimal Policy."

Of particular interest is the skyrocketing cost of the Kyoto Protocol when it is broadened to include all countries (Figure 1-24). Nor, as we will see, are the environmental gains from Kyoto that significant. Nordhaus and Boyer note that "emissions, concentrations, and temperature increases under the Kyoto Protocol are very close to the base policy because it has little impact on global emissions" (129). This is for two reasons: (1) Kyoto only targets high income regions, and (2) Nordhaus and Boyer are assuming "continuing decarbonization and slower population growth over the next century" (143) in high-income countries. From what we have seen, one has to wonder what Nordhaus and Boyer are seeing in their crystal ball that leads them to conclude that "CO₂ emissions in the high-income regions are projected to be relatively flat over the next century" (143). The caveat we should attach to Nordhaus and Boyer's projections, then, is that the estimates that are put into their models are on the conservative side. Their general point, though, still stands. It is that developing countries, the very countries excluded by Kyoto, will be major emitters in this century and the next.

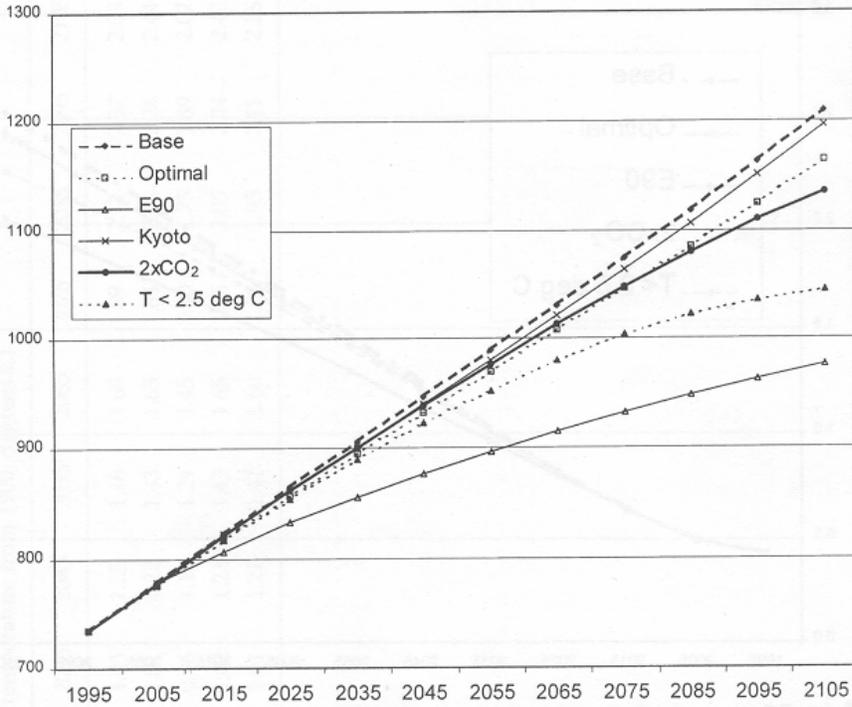


Figure 1-26. CO2 concentrations, GtC, for alternative policies. (Nordhaus and Boyer, 139).

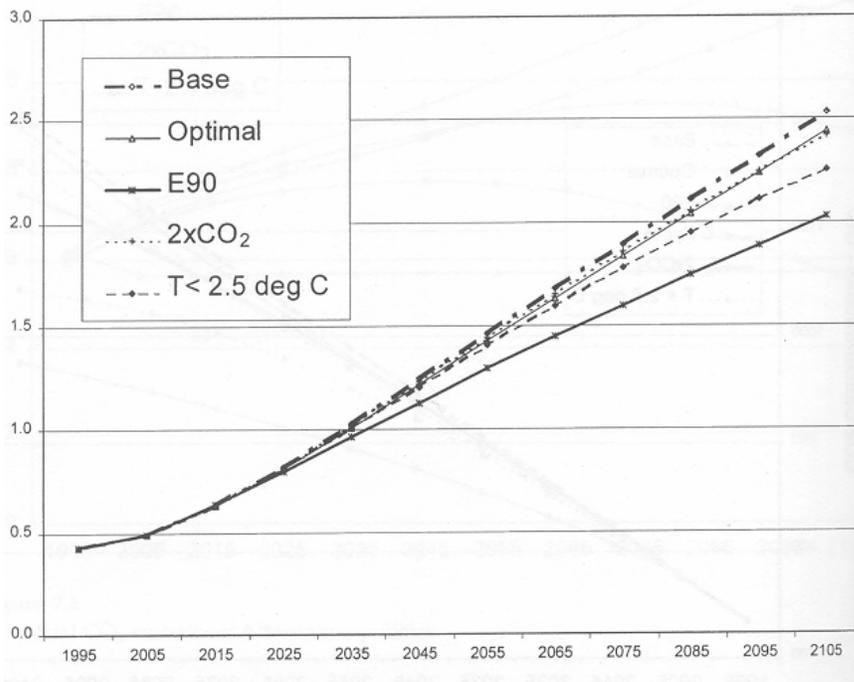


Figure 1-27. Global mean temperature increase from 1900 -- degrees C. (Nordhaus and Boyer, 140).

Nordhaus and Boyer observe that "one of the surprising results of virtually all policies is how little they affect the temperature trajectory in the next century" (140) (see also figures 1-29 and 1-30). This again seems to be a result of the conservative estimates of their input. They go on to note, however, that "the policies have a more substantial impact in the next century. The temperature reduction in 2200 relative to the baseline of the optimal, concentration target, and temperature target are .2, .88, and 1.37 degrees C, respectively" (140). Once again, we should remind ourselves of the Hegelian point of this analysis: quantitative increases or decreases have qualitative results.

The following figures analyze the Kyoto Protocol in more detail. If we have learned anything from Hegel, it is that determining the proper course of action is a matter of eliminating the improper courses of action. The runs for the analysis of the Kyoto Protocol are basically the same as the scenarios above, with a few more details.

1. *Reference*: no controls
2. *Optimal*: sets emissions by region and period to balance the costs and benefits of emissions and reductions.
3. *Kyoto emissions limitations*:
 - a. No trade: no trade among 4 major annex blocs
 - b. OECD trade: emissions trading limited to OECD countries
 - c. Annex I trade: emissions trading limited to Annex I countries
 - d. Global trade: emissions trade among all regions
4. *Cost effectiveness benchmarks*:
 - a. Limit atmospheric concentrations to those resulting from the Kyoto Protocol case 3c (for period after 2050).

b. Limit global mean temperature to that resulting from the Kyoto Protocol Case 3c
 (for period after 2100). (From Nordhaus and Boyer, 147).

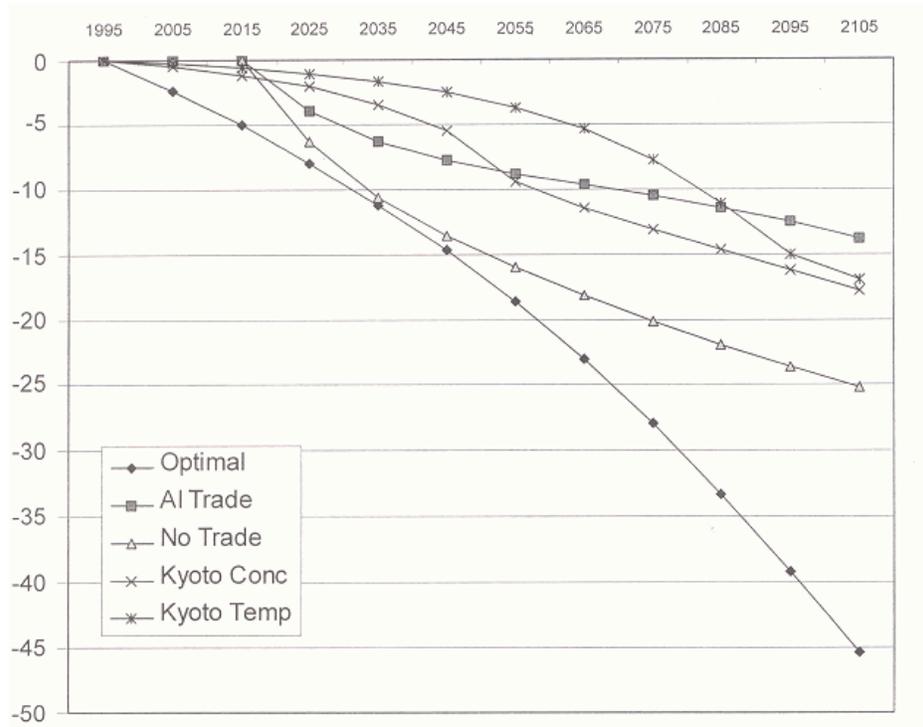


Figure 1-28. Atmospheric CO2 concentration. Difference from base -- GtC. (Nordhaus and Boyer, 152)

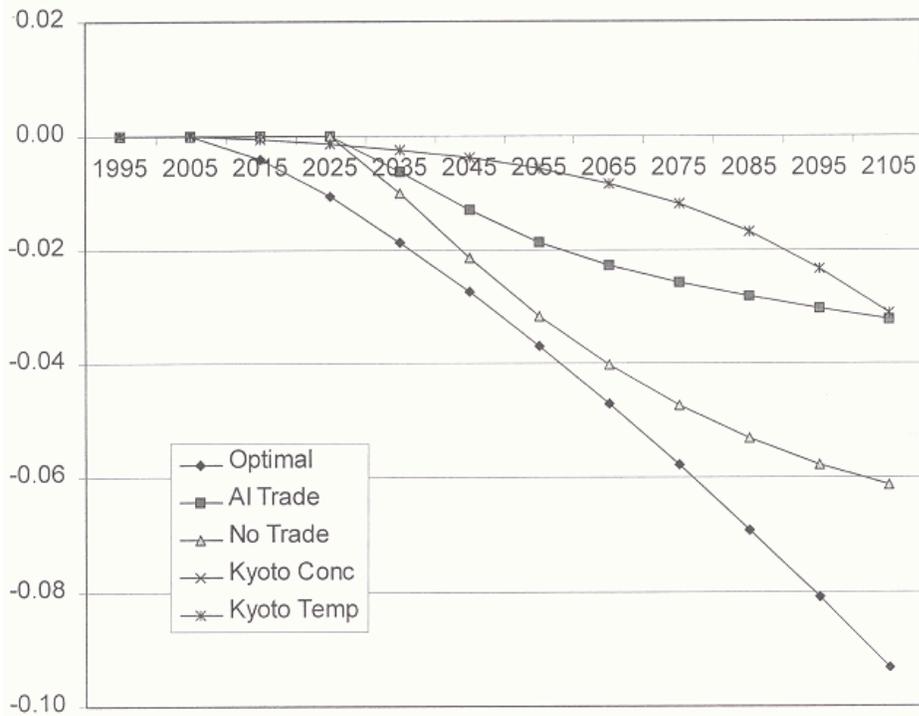


Figure 1-29. Global temperature increase. Difference from base -- degrees C. (Nordhaus and Boyer, 153).

	Atmospheric temperature (degrees C increase from 1900)		
	1995	2055	2105
Base	0.43	1.46	2.53
Optimal	0.43	1.43	2.44
Kyoto concentrations	0.43	1.45	2.49
Kyoto temperature	0.43	1.46	2.50
Global	0.43	1.45	2.50
AI trade	0.43	1.45	2.50
OECD	0.43	1.43	2.47
No trade	0.43	1.43	2.47

Figure 1-30. Comparison of global mean temperature increase in different runs. (Nordhaus and Boyer, 153).

Regarding Figure 1-28, Nordhaus and Boyer note that the "Kyoto Protocol has higher concentrations than the optimal run because it leaves uncontrolled the emissions from low income regions. The Kyoto Protocol makes little headway in reducing CO2 concentrations under any trading scheme" (150). As mentioned, none of the scenarios significantly affects temperature in this century. And "the emissions and concentrations implicit in the Kyoto Protocol are close to those in the optimal policy for the first few decades, but they are too low relative to the efficient policy over the next century."

Nordhaus and Boyer conclude that "the Kyoto Protocol has no grounding in economics or environmental policy" (167). The following cost-benefit analysis makes this clear. And remember, for Hegel the relation between two numbers in a ratio is qualitative. It is this qualitative relation between two quantities that is under consideration.

Abatement costs in different regions for different policies (billions of 1990 U.S. dollars)

	Base	Optimal	Kyoto concentration	Kyoto temperature	Global	AI trade	OECD	No trade
USA	0	15	1	0	91	325	710	852
OHI	0	1	-1	-1	7	24	16	39
Europe	0	1	-1	-1	0	-5	-93	15
EE	0	12	2	1	-28	-112	-2	-2
MI	0	5	0	0	-2	-3	-4	-4
LMI	0	23	4	3	-2	-4	-5	-5
China	0	14	2	0	-4	-3	-4	-4
LI	0	27	5	3	-2	-5	-7	-8
Annex I	0	29	1	-1	70	232	630	905
ROW	0	69	11	7	-11	-15	-20	-21
World	0	98	12	5	59	217	611	884

Figure 1-31. Discounted global costs of different targets or control strategies. The estimates are the discounted consumption in the base case minus the discounted consumption in the case in question, where these have been calculated excluding the environmental benefits of controls. Revenues from permit trading are implicit in the calculations. (Nordhaus and Boyer, 159). OHI = Other High Income, EE = Eastern Europe, MI = Middle Income, and so forth.

Net economic impacts in different regions for different policies (billions of 1990 U.S. dollars)

	Base	Optimal	Kyoto concentration	Kyoto temperature	Global	AI trade	OECD	No trade
USA	0	22	12	10	-78	-313	-692	-833
OHI	0	26	10	9	3	-15	-2	-26
Europe	0	126	47	36	47	46	161	54
EE	0	-9	-1	0	29	113	3	3
MI	0	19	8	7	11	11	17	18
LMI	0	5	6	5	13	13	20	21
China	0	-10	0	1	5	4	6	6
LI	0	20	12	9	19	21	32	34
Annex I	0	164	69	56	0	-170	-530	-801
ROW	0	34	26	21	48	49	75	78
World	0	198	95	77	49	-121	-455	-723

Figure 1-32. Total impacts of different targets or control strategies for different regions, including environmental benefits and net sales emissions permits. The estimates are the difference between the present value of consumption in the case in question and the present value of consumption in the base. Positive values reflect net benefits while negative ones reflect net costs. (Nordhaus and Boyer, 160)

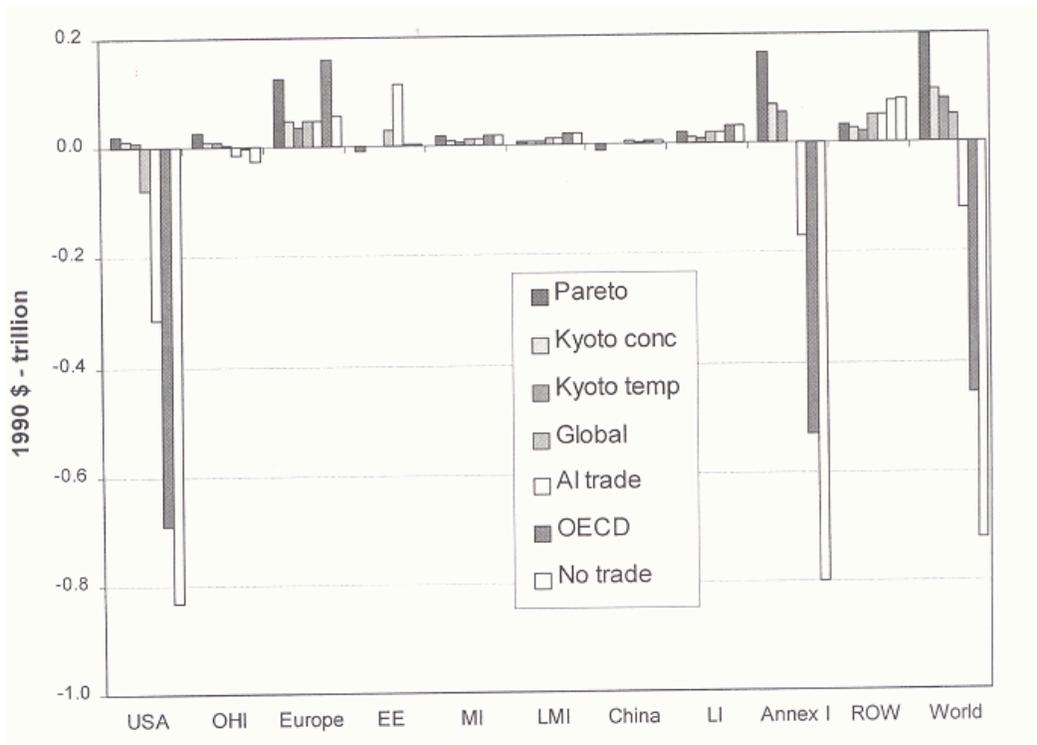


Figure 1-33. Net economic impact by region. (Nordhaus and Boyer, 162).

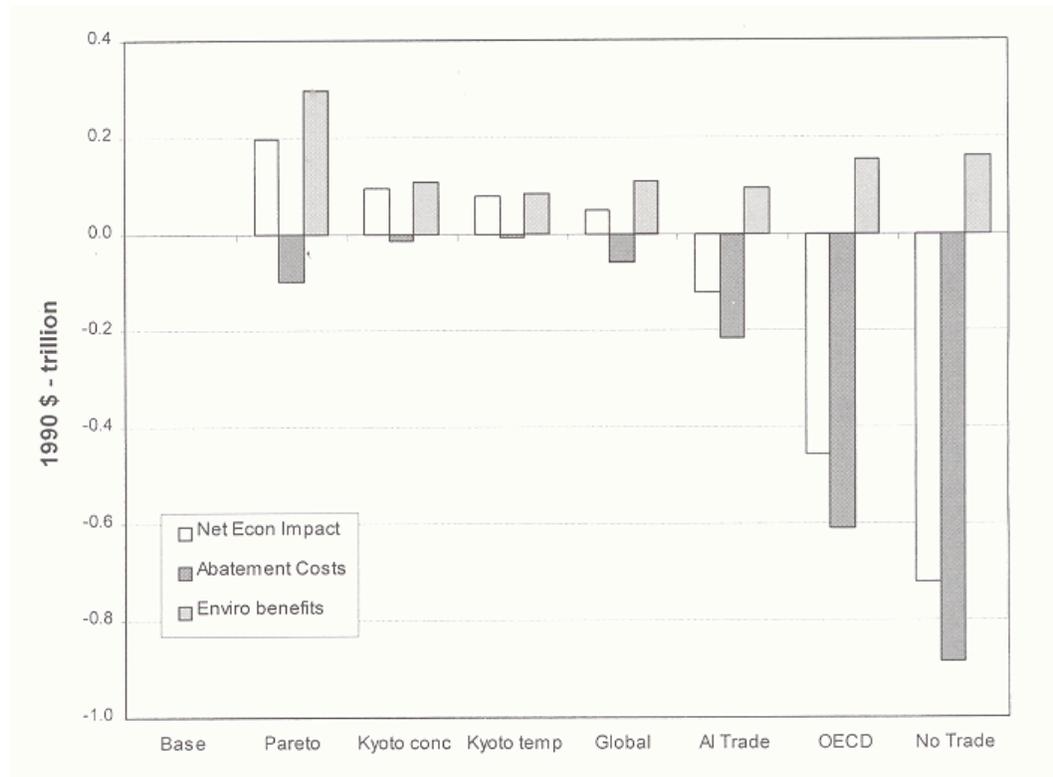


Figure 1-34. Impacts of alternative strategies. (Nordhaus and Boyer, 163).

Benefits, costs, and benefit-cost ratio of different approaches (costs and damages in billions of 1990 U.S. dollars)

	Base	Optimal	Kyoto concentration	Kyoto temperature	Global	AI trade	OECD	No trade
Abatement costs	0	98	12	5	59	217	611	884
Reduction in damages	0	296	107	83	108	96	155	161
Benefit-cost ratio	na	3.02	9.07	15.22	1.82	0.44	0.25	0.18

Figure 1-35. Calculations show the abatement costs and reduction of climate damages from alternative policies. Costs and damages are in billions of dollars discounted to 1995 in 1990 U.S. dollars. (Nordhaus and Boyer, 164).

As intimated in Figure 1-33, Europe has the most to gain from any policy. This is because Europe has the most to lose, in terms of damages, from climate change. We

have already seen one striking example. The United States has the most to lose in pure economic terms partly because it is already the world's largest emitter. An ill-conceived policy will be especially detrimental to the United States.

In this regard, some prominent policies look highly inefficient. Nordaus and Boyer rank such policies from bad to worst: Kyoto (Annex I trading), Kyoto (OECD trading), limiting CO₂ concentrations to twice preindustrial levels, Kyoto (no trading), limiting climate change to 2.5 degree C temperature rise, stabilizing global emissions at 1990 levels, and limiting climate change to a 1.5 degree C temperature (175).

None of the policies has major net economic benefits. The optimal policy reduces the global temperature rise to 2.24 degrees C in 2100 and to 3.65 degrees C in 2200. And, as shown in Figures 1-25 and 1-35, it has discounted benefits of reduced damages of about \$300 billion for a benefit-cost ratio of 3. Generally, the ratios in Figures 1-25 and 1-35 tell the tale. As shown in figure 1-25, the other two environmentally oriented policies, concentration limits and limiting CO₂, have discounted benefits of about \$700 and \$1,100 billion, for benefit-cost ratios of one-half and one-third, respectively (175). Figure 1-35 shows that "the cost-effectiveness of the Kyoto Protocol will depend crucially on how it is implemented" (177). In the global trading version, where all nations (including undeveloped ones) enter into an efficient trading arrangement and all policies are efficiently implemented, the costs are \$59 billion, while the benefits for emissions reductions are around \$108 billion, for a benefit-cost ratio of 1.8. The problem with this scenario is again the unruly relations among the many contributors to the greenhouse problem. The policy assumes participation of nations that are unwilling to participate, such as the United States, and in some cases unable to participate (177).

From all this we can see Hegel's point that it takes a quantitative analysis to assess qualitative results.

Overall, Nordhaus and Boyer conclude that "the Kyoto Protocol has no economic or environmental rationale. The approach of freezing emissions for a subgroup of countries is not related to a particular goal for concentrations, temperature, or damages. Nor does it bear any relation to an economically oriented strategy that would balance the costs and benefits of greenhouse-gas emissions" (177, my emphasis). In Hegelian terms, a quantitative cost-benefit analysis shows that the Kyoto Protocol is qualitatively unacceptable. It does not constitute a "reasonable measure."

Clearly, something like the optimal strategy does constitute a reasonable measure. Economic policies should not cause more harm than they are meant to ameliorate. The major obstacle, of course, is establishing an international trading system. Or we could put the point in Hegel's vernacular: the major barrier is establishing proper relations between the many components of the system of relations that will mitigate or exacerbate greenhouse warming.

Along these lines, an alternative strategy is to coordinate "policies and measures" among nations. Countries "could pick and choose what best suits their local circumstances -- some might adopt price instruments, others could impose emissions caps, and still other countries would resort to technology standards, voluntary agreements, or sundry other instruments" (Victor, 2001, 90). In the case of either an optimal carbon tax or coordinated measure, for better or worse "what is needed is an international institution that can pass judgment on whether national policies conform with

international standards -- a politically delicate task that is feasible only once parties are confident that the international mechanism can work impartially" (Victor, 89).

In the United States and other larger countries an *intra*-national trading system is not a bad start. Following Hegel's logic that a quantitative assessment is necessary to arrive at qualitative results, I close this section by examining a "safety-valve" proposal that is something like Nordhaus and Boyer's optimal strategy. Its authors state:

The idea of a safety valve is very simple. A specific emissions cap is established, for which allowances will be created, and allocated at no cost. As in any cap-and-trade system, these allocated allowances may be traded freely, with the only constraint being that companies subject to the cap will have to eventually hold enough allowances to cover their emissions in each compliance period, and surrender that amount back to the government. Compliance assures that emissions will be no higher than the mandated cap; however, there is no guarantee on the price of the allowances, or the associated cost of compliance. A safety valve is a promise by the government that it will make an unlimited number of additional allowances available in each year at a prespecified 'trigger' price. This promise ensures that allowance prices will never rise above the trigger price, and thus it limits the level of overall compliance costs as well. In turn, of course, emissions will exceed the official cap in any year where the safety valve is triggered.

There is no question that a safety valve may increase emissions above the official level of the cap. The more important policy question, however, is whether a more cost-effective and a more politically acceptable GHG policy [greenhouse gas] can be created by the introduction of the safety valve provision into a cap-and-trade system (Smith and Bernstein, 2004, 6).

Smith and Bernstein use the amended McCain-Lieberman bill, voted on in 2003, as the benchmark GHG cap policy. That bill sought to limit emissions to 2000 levels in the United States. There are two types of safety-valves. One is a flat safety valve, in which the trigger price remains constant. The other is a rising safety, where the price increases over time. See Figure 1-36 below.

	2010	2020	2030	2040	2070
Safety-Valve Rising (SVR)	\$15	\$24	\$40	\$65	\$280
Safety-Valve Flat (SVF)	\$15	\$15	\$15	\$15	\$15

Figure 1-36. Price in \$/tonne carbon. (Smith and Bernstein, 12).

Smith and Bernstein found that the SVR policy "achieves about 90% of the emissions reductions for 57% of the cost of the [benchmark] pure cap-and-trade policy. The SVF policy achieves about 20% of the emissions reductions at a present value of cost that is about 17% of the pure cap and trade policy" (19). Figure 1-37 illustrates the relative cost-effectiveness of these results.

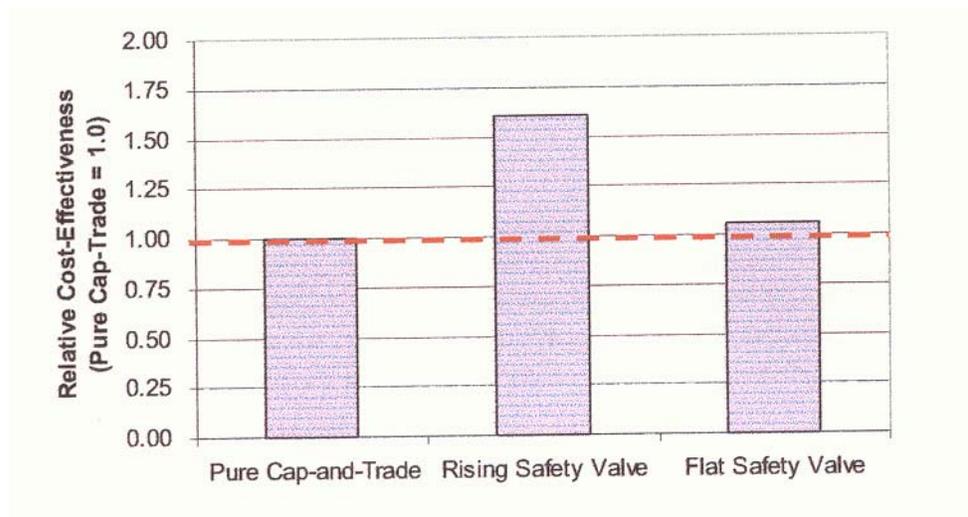


Figure 1-37. Cost-effectiveness of safety valve scenarios relative to pure cap-and-trade. Normalized so that cost-effectiveness of pure cap-and-trade = 1.0 (dotted red line). (Smith and Bernstein, 20).

"The purpose of the safety-valve is to manage uncertainties in cost," state Smith and Berstein (19). It does so through gradual transitions and smaller economic shocks, better allowing the economy to respond to the long-term need to reduce cumulative emissions (16). The safety-valve is by no means draconian, yet it does force companies to absorb the costs of their pollution.

Figures 1-38 through 1-40 show the energy market and macroeconomic impacts of the safety-valve system relative to pure cap-and-trade. It is these sorts of figures that sank the McCain-Lieberman bill. Similar as the bill was to Kyoto, those who voted against the bill were not without good reason for doing so (if this was their reason). The bill was only defeated by a 43-55 margin. Many of the Nays expressed support for "internalizing the greenhouse externality" but were worried about the economic impacts. As Hegel has taught us, a solid quantitative analysis can have qualitative effects. So an economically (quantitatively) viable strategy will go a long way towards alleviating these worries. Still more important is that in a cap-and-trade system "studies show that awarding just 10 percent of carbon emissions permits to the hardest-hit stakeholders -- coal mining firms in particular -- could blunt their opposition by offsetting their immediate losses as the economy shifts away from carbon intensive fuels" (Victor, 2004, 33). The economic efficiency of a scheme that diverts large resources to an industry that quite simply has no place in a low-carbon world is questionable, and there is something ethically disquieting about the notion that "special handouts could be used to blunt opposition and reward politically powerful constituencies." But such allocations are probably necessary as a matter of political expediency (Victor, 33). The hardest-hit stakeholders must be paid to play.

	Pure Cap-and-Trade		Safety-Valve Rising		Safety-Valve Flat	
	2010	2020	2010	2020	2010	2020
Electricity ¹⁰	7%	10%	3%	6%	3%	4%
Coal	51%	87%	17%	45%	17%	26%
Natural Gas	12%	18%	4%	10%	4%	6%
Refined Petroleum Products	12%	16%	4%	9%	4%	6%

Figure 1-38. Estimated percentage change in total end-user prices for fuels under the three scenarios (including effect of carbon price). (Smith and Bernstein, 16).

	Pure Cap-and-Trade		Safety-Valve Rising		Safety-Valve Flat	
	2010	2020	2010	2020	2010	2020
Electricity	-3.7%	-6.0%	-1.4%	-3.4%	-1.3%	-2.1%
Coal	-23%	-46%	-10%	-31%	-10%	-21%
Natural Gas	0.9%	1.7%	0.4%	1.3%	0.3%	0.8%
Refined Pet. Products	-2.8%	-4.8%	-1.0%	-2.7%	-1.0%	-1.7%

Figure 1-39. Estimated change in energy production under the three scenarios. (Smith and Bernstein, 16).

	Pure Cap-and-Trade (low end of range)		Safety-Valve Rising		Safety-Valve Flat	
	2010	2020	2010	2020	2010	2020
GDP (%)	-0.17%	-0.36%	-0.02%	-0.09%	-0.04%	-0.07%
Consumption (\$/HH)	-\$352	-\$528	-\$101	-\$173	-\$72	-\$80
Utility (\$/HH)	-\$90	-\$201	-\$66	-\$116	-\$14	-\$54
Present Value of Utility Impact Through 2070 (\$/HH)	-\$5597		-\$3165		-\$997	

Figure 1-40. Macroeconomic impact estimates for three climate change policies. (Smith and Bernstein, 18).

Figures 1-38 and 1-39 show that coal will bear the brunt of any climate change policy. Figure 1-39 shows that "the impacts of the safety valve options are only about one-third to one-half the impact of the pure cap-and-trade" scenario (16). The last row in Figure 1-40 "provides the present value of estimated household costs through 2070" (18). This can be thought of "as a one-time-up-front payment that is equal to the entire stream of costs that will be borne through 2070, and is useful as a single summary of the relative costs of the three policy scenarios" (18). It should also be noted that the numbers for pure cap-and-trade reflect the *lowest* end of cost estimates for Smith and Bernstein's of the McCain-Lieberman bill. "The upper bound of the costs of the pure cap case was more than double the lower bound." And for similar alternative assumptions the safety-valve scenarios "show little or no upward sensitivity" (18).

The point of all this, again, is Hegelian: an economically or quantitatively viable plan is a prerequisite for mitigating the qualitative effects of climate change. Ill-conceived policies can inflict more harm than they are meant to mitigate. Instead, something like a Pareto-optimal strategy or, more simply, a safety-valve measure should be considered. Although it takes time to implement such measures, and many obstacles have to be overcome, Nordhaus and Boyer suggest that we still have a window. Otherwise, future generations will pay the price, literally and figuratively, for our inability to overcome the barriers bound up with our "ought." Second, it should be evident that the germ of quality was implicit in quantity. From becoming, to determinate being, to finitude and infinity, the ought, being-for-self, and the one and the many -- all these categories already included quantity. None of the aspects of climate change spelled out through the categories of quality are complete without being complemented by

quantity. Likewise, a quantitative analysis is just that, *merely* quantitative, without a qualitative aspect. The qualitative side a quantity is almost literally quality of life, which will be affected either by damages caused by climate change or (for better or worse) by policies put in place to prevent such damages. So, as Hegel demonstrates, quality and quantity are inseparable: they are like two sides of the same coin, and each automatically implies the other. "Measure" is the culmination of the relation between quantity and quality.

Measure

Hegel's treatment of measure is notoriously obscure. Hartnack notes that "the various commentators' comments on Hegel's treatment of this particular category range from 'very complex' (Taylor) to 'one of the most difficult and obscure in Hegel's writings' (Findlay), not to mention Errol E. Harris's comment in his book *An Interpretation of the Logic of Hegel*: 'On this topic the greater Logic is so obscure as to be, for the most part, hardly intelligible" (Hartnack, 1998, 35, n.34). The category of measure is not that difficult to navigate when one is guided by the following principle. Measure is *both* (a) an arbitrary, external imposition on materially existing things *and* (b) an intrinsic aspect of materially existing things. (a) and (b) are, again, two sides of the same coin. Hegel expresses (b) in writing that "the different forms in which measure is realized belong also to the different spheres of *natural* reality" (331, my emphasis). Another way of putting this point is that *measure*, per se, is **in** natural reality, whereas *units of measurement* are "externally related" to nature. For example, if a stick is two meters in length "2," "meters," and "in length" are (a) arbitrary symbols of (b) the measure of the stick. Or 2.5 degrees C and 4.5 degrees F are (a) different *external* measurements of (b) a measure

immanent **in** natural reality. In whatever terms (a) is couched -- (a) could just as well be
"/:;><.)" " _=}}}} " "!#^^< " -- (a) and (b) are inseparable. If a yardstick were an inch
longer or shorter, it would not be a yard stick.

On this view of measure, then, an alteration of quantum alters the quality of
natural reality. But there is another, equally justifiable, sense of measure in which
quantity can vary within certain limits before altering the quality of natural reality when
the limits are crossed. We saw as much in "Determination, Constitution, and Limit,"
where CO2 level can quantitatively increase only so far before the world begins to warm,
the upper layers of the oceans can only quantitatively absorb so much of the warmth, and
the climate system has certain limits at which it is affected by a quantitative increase in
surface temperature. An earth whose average mean annual temperature is *quantitatively*
increased by 3 degrees C (5.4 degrees F) is a *qualitatively* different earth. Precipitation
increases because of the moisture in the air, most non-polar glaciers are already in the
process of disappearing, leading Senator McCain to remark that "Glacier National Park"
in Montana will soon have to change its name, tropical diseases spread, and the list
continues.

So in measure quantity and quality are *immediately* united: "Measure, still as
such, is itself the *immediate* unity of quality and quantity; its moments are determinately
present as a quality, and quanta thereof" (330). "In measure the qualitative moment is
quantitative; the determinateness or difference is indifferent and so is no difference, is
sublated. This nature of quantity as a return-into-self in which it is qualitative constitutes
that being-in-and-for-itself which is essence" (330). Essence is the next category, and it

begins Book II. We must now determine how measure is "*realized* in its own notion," how its immediacy is mediated and passes into essence.

Specific Quantity

In the second section on measure, "Specifying Measure," Hegel delineates the two sides of measure. "The existence of measure, then, which is *intrinsically* magnitude, is in its behavior towards the existence of the alterable, external aspect, a sublating of its indifference, a *specifying measure*" (336). These, again, are the two sides of measure. Measure is (a) an *external* magnitude attached to a quality, say 2.5 degrees C, and (b) measure is an *intrinsic* magnitude that *specifies* what something is, the world is on average 2.5 degrees C warmer.

In the "Remark" to "Specifying Measure" and the following section, "Relation of the Two Sides as Qualities," Hegel explains how measure is **in** natural reality through an example that works just like global warming. His example is that as temperature increases objects absorb heat at a different rate. I will quote the example in full since it has a particular bearing on the issue at hand. Note that from the start temperature is a quality. Temperature is quality because as it quantitatively increases or decreases it has a commensurate concrete effect.

To cite an example, *temperature* is a *quality* in which these two sides [(a) and (b)] of external and specified quantum are distinguished. As a quantum it [a] is an external temperature, and that too, of a body as a general medium, and it is assumed that the alteration of the temperature proceeds on the scale of arithmetical progression, increasing or decreasing uniformly. On the other hand, the particular bodies in the medium differ in the way they absorb the temperature, *for through their immanent measure* [my emphasis] [b] they determine it as received from outside themselves and the change of temperature in any one of them does not correspond in a direct ratio with that of the medium or of the other bodies among themselves...[T]he thermal capacities of bodies vary in different temperatures and associated with this is a change in the specific shape [objects expand when heated]. Thus a particular specification is manifested in the increase or decrease of the temperature...the increase or decrease of this heat [in the bodies] does not proceed

uniformly with the increase or decrease of the external heat. Here a temperature is assumed which is [a] purely external and whose changes are merely external and quantitative. But the temperature is itself [b] the temperature of the air or some other specific temperature. The ratio, therefore, if looked at more closely, would strictly speaking have to be taken not as the ratio of a merely quantitative quantum [an external magnitude of temperature expressed by a number and degrees] to a qualitative one [the quality of the respective bodies explains how they differ in absorbing heat], but as two specific quanta [the temperature in air and the temperature of the bodies]. In fact, the determining of the specifying ratio [when one side of the ratio alters so must the other] has now advanced to the stage where *the moments of measure not only consist of a quantitative side and a side qualifying the quantum, but are related to each other as two qualities which are in themselves measures* [my emphasis] (338-339).

The relation between the temperature of the air and how bodies react differently to an alteration in this temperature is a relation between two qualitative quanta. Each side, both the air temperature and the bodies, has as aspect that is at once qualitative and quantitative. Numbers alone are not simply going up and down: the very nature of material reality changes when temperature alters. Thus the moments of measure are two qualitative quanta (the air temperature and the bodies) relating to each other. To give another example, "warming drives sea-level rise through thermal expansion of seawater" (IPCC, 51), leading to coastal flooding and inundation of island atolls. A quantitative increase in warming, in the simple form of the temperature rising, is a qualitative alteration that is reflected in the qualitative alteration of sea water, inasmuch as the expansion of sea water is a quantitative alteration.

The crux, again, is that quality and quantity are inseparable. When one changes so must the other. Figures 1-41 through 1-46 demonstrate Hegel's account of measure to the letter. Remember that in Hegel's example objects absorb heat at a different rate because of their different internal natures. Hegel calls the latter "the nature of their qualities." Objects interact with one another according to their qualities. Remember, too, that an internal nature, something's quality, is constituted by external relations. When the

relations are altered, in this case when the relations are quantitatively increased or decreased, so is the internal (qualitative) nature.

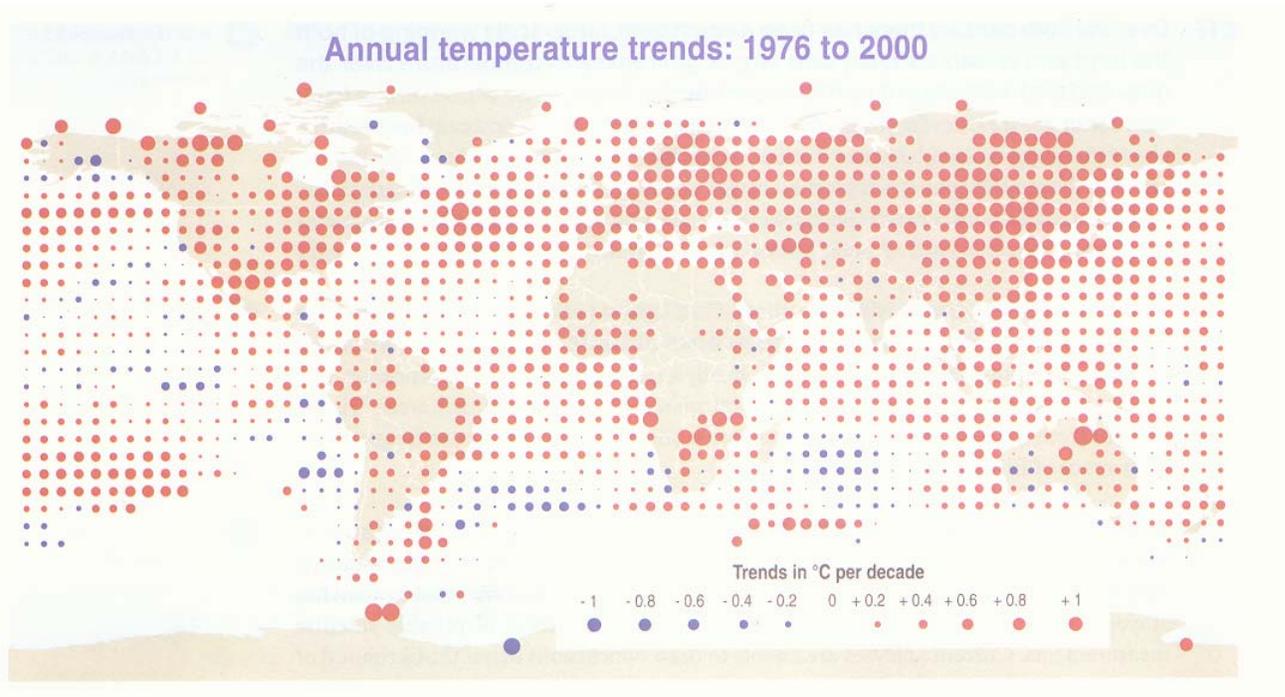


Figure 1-41. A consistent, large-scale warming of both the land and ocean surface occurred over the last quarter of the 20th century, with largest temperature increases over the mid- and high latitudes of North America, Europe, and Asia. Large regions of cooling occurred only in parts of the Pacific and South Oceans and Antarctica. The warming of land faster than ocean surface is consistent both with the observed changes in natural climate variations such as the North Atlantic and Arctic Oscillations and with the modeled pattern of greenhouse-gas warming. (Graph and text reprinted from IPCC, 2001, 54).

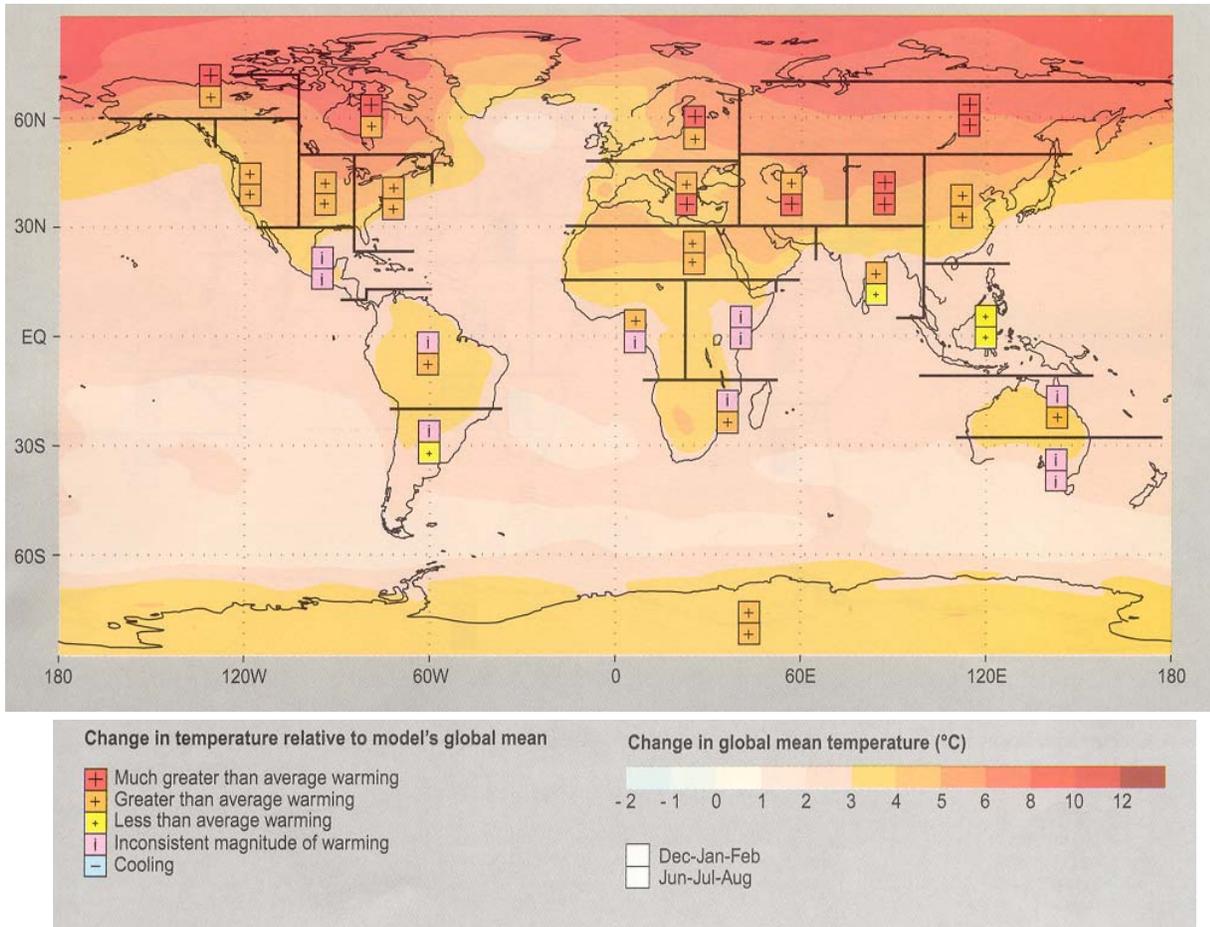


Figure 1-42. Projected regional changes in temperature for a global mean annual average warming spanning 1.2 to 4.5 degrees C for the period 2071 to 2100 relative to the period 1961 to 1990. (Reprinted from IPCC, 2001, 65).

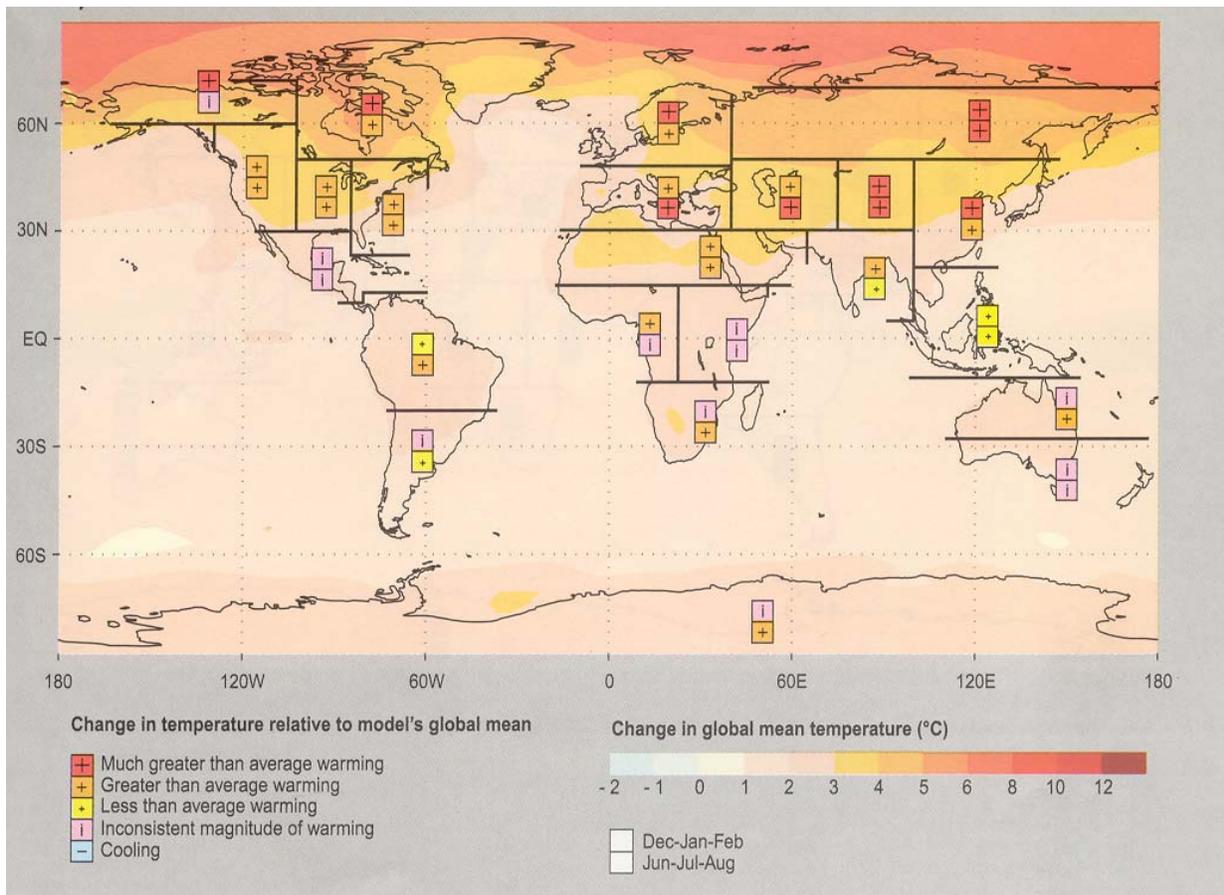


Figure 1-43. Projected regional changes in temperature for a global mean annual average warming of .9 to 3.4 degrees C for the 2071-2100 relative to the period 1961-1990. (Reprinted from IPCC, 2001, 65).

Several items are noteworthy. First, "it is very likely that all land areas will warm more rapidly than the global average, particularly those at northern high latitudes in winter" (IPCC, 64). Warming in the northern regions of North America and northern and central Asia "exceeds global mean warming in each model by more than 40%" (64). Second, significant warming occurs in glacial regions, known as the "cryosphere," in the Arctic, Alaska, Canada, and Greenland. Third, as in the example of rice in the

Philippines in the Introduction, nighttime temperatures tend, on average, to be higher than what they were before.

A similar scenario holds for how precipitation patterns are affected by global warming; yet another relation between "two qualities which are in themselves measures."

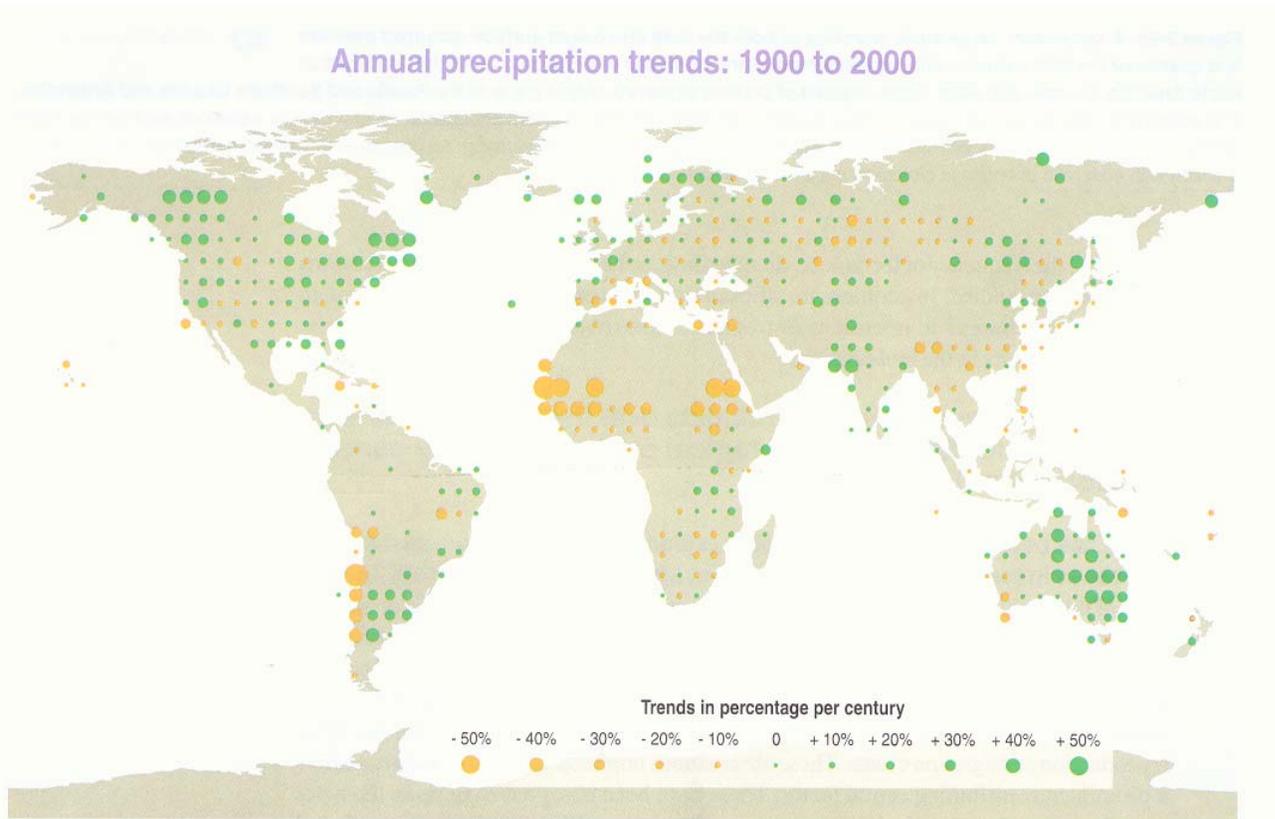


Figure 1-44. Precipitation during the twentieth century has on average increased over continents outside the tropics but decreased in the desert regions of Africa and South America. While the record shows an overall increase consistent with warmer temperatures and more atmospheric moisture, trends in precipitation vary greatly from region to region and are only available over the twentieth century for some continental regions. (Text and Graph reprinted from IPCC, 2001, 53).

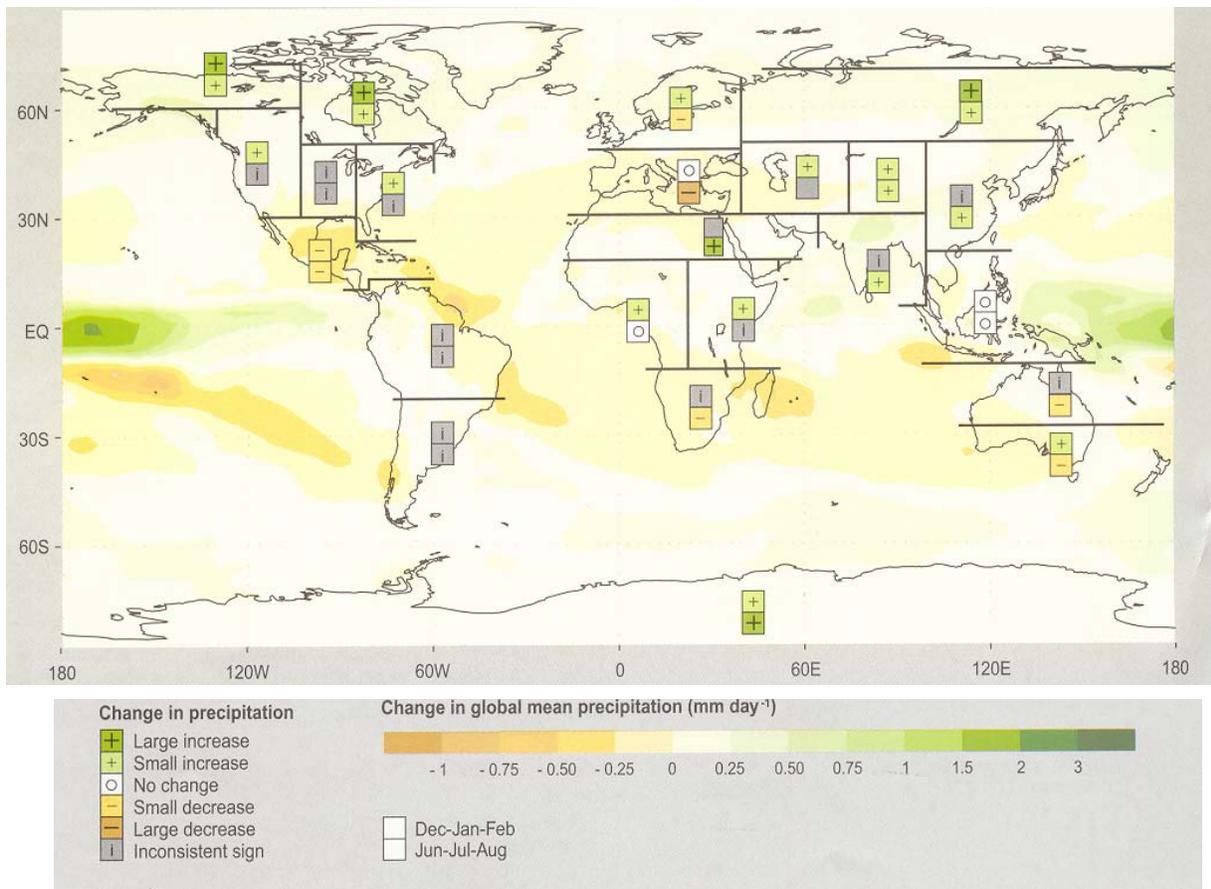


Figure 1-45. Change in precipitation for a global mean annual average warming spanning 1.2 to 4.5 degrees C for the period 2071 to 2100 relative to the period 1961 to 1990. (Reprinted from IPCC, 2001, 66).

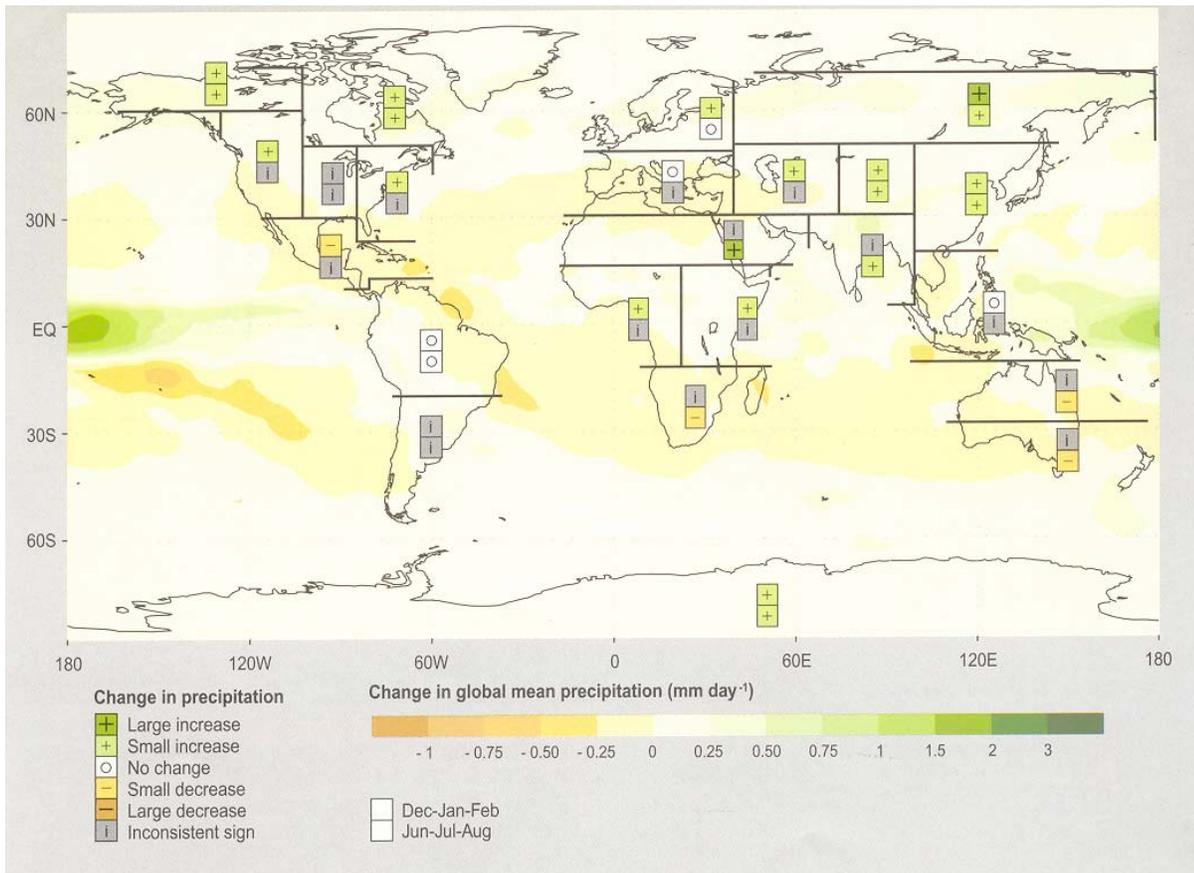


Figure 1-46. Change in precipitation for global mean annual average warming of .9 to 3.4 degrees C for the 2071-2100 relative to the period 1961-1990. (Reprinted from IPCC, 2001, 66).

For future reference, we should note that precipitation has increased significantly over northern Russia and this trend is expected to continue as the world warms. Also, the significant decrease in rainfall in the region just below the Sahara desert in Africa is probably bound up with the albedo effect discussed in "Infinity." Whether the clearing of vegetation alone can account for such a significant decrease remains to be determined. In measure, a quantitative dimension is added to the notion that when the relations of which

something is constituted alter, so does that something. Figures 1-41 through 1-46 make this quite evident with regard to climatic processes.

Figures 1-41 through 1-43, in particular, are examples of what Hegel calls "realized" or "real" measure.

It is in this distinguishedness of the quantum from itself that it first shows itself to be a real measure; for it now appears as a determinate being which is both one and the same (e.g. the constant temperature of the medium) [or global annual mean average warming], and also quantitatively varied (in the different temperatures of the bodies present in the medium) [or the different regional rates of warming and precipitation due to warming]. This distinguishedness of the quantum in the different qualities (the different bodies) [or regions] gives a further form of measure, that in which two sides are mutually related as qualitatively determined quanta. This can be called *realized measure* (340).

Real Measure is essentially no different from "Being-for-self in Measure." Let us recap, one final time, the two sides of measure. Measure is (a) an *external* magnitude attached to a quality, and (b) measure is an *intrinsic* magnitude that *specifies*, or now *realizes*, what exactly something is. "The fact, however, that the two sides of measure are themselves measures, the one immediate and external [this is (a)], and the other immanently specified [(b)], both being contained within the unity of measure itself, means that measure now further determined, is *realized*. As this unity, measure contains the relation in which the magnitudes are determined and posited as differently specified by the nature of their qualities" (347). Predictably, (a) and (b) are the same thing. The unit of measurement "a yard" *really does constitute* a yardstick. A global average annual mean temperature increase of 2.5 degrees C *really does constitute* the material composition of the air and the atmosphere, and an increased warming of x degrees C is really reflected **in** its regional impacts and precipitation patterns. The nature and subsistence of *materially existing individuals* "lies in their measure determinateness" (347).

Real Measure

I can now make good on the argument I gave in the Introduction. Logical categories can and should be applied to materially existing individuals. In real measure, materially existing individuals relate to other materially existing individuals according to their respective measures. The one system of relations that comprises global climate change, which is actually formed from the interaction of many systems of relations, bears out this Hegelian principle. Socio-economic relations among human beings and with nature increase CO₂ emissions, CO₂ emissions increase surface temperature, increased surface temperature affects climate, climate in turn affects relations among human beings, the environment, and other animals -- all these relations are measure-relations. "Measure, as now real measure, is first a self-subsistent measure *of a material thing which is related to others and in this relation specifies them and with them their self-subsistent materiality* [my emphasis]. This specification of an external relating to a plurality of others in general produces other relations and hence other measures" (348). Once again, materially existing things are comprised of the relations into which they enter. Such relations are measure-relations. So when things enter into new relations new measures are created, as with the interlocking system of relations above.

Measure-relations are the extension of extensive and intensive magnitude. As the world warms, (a) the extensive magnitude of greenhouse gases and temperature increase, while (b) the magnitude of the effects commensurate with this increase *intensifies*. The extensive magnitude is a continuum and the intensive magnitude is discrete events along this continuum. The continuum corresponds to side (a) of measure, while the discrete

events along the continuum correspond to side (b) -- and the two sides are inseparable.

Figure 1-47 illustrates this point.

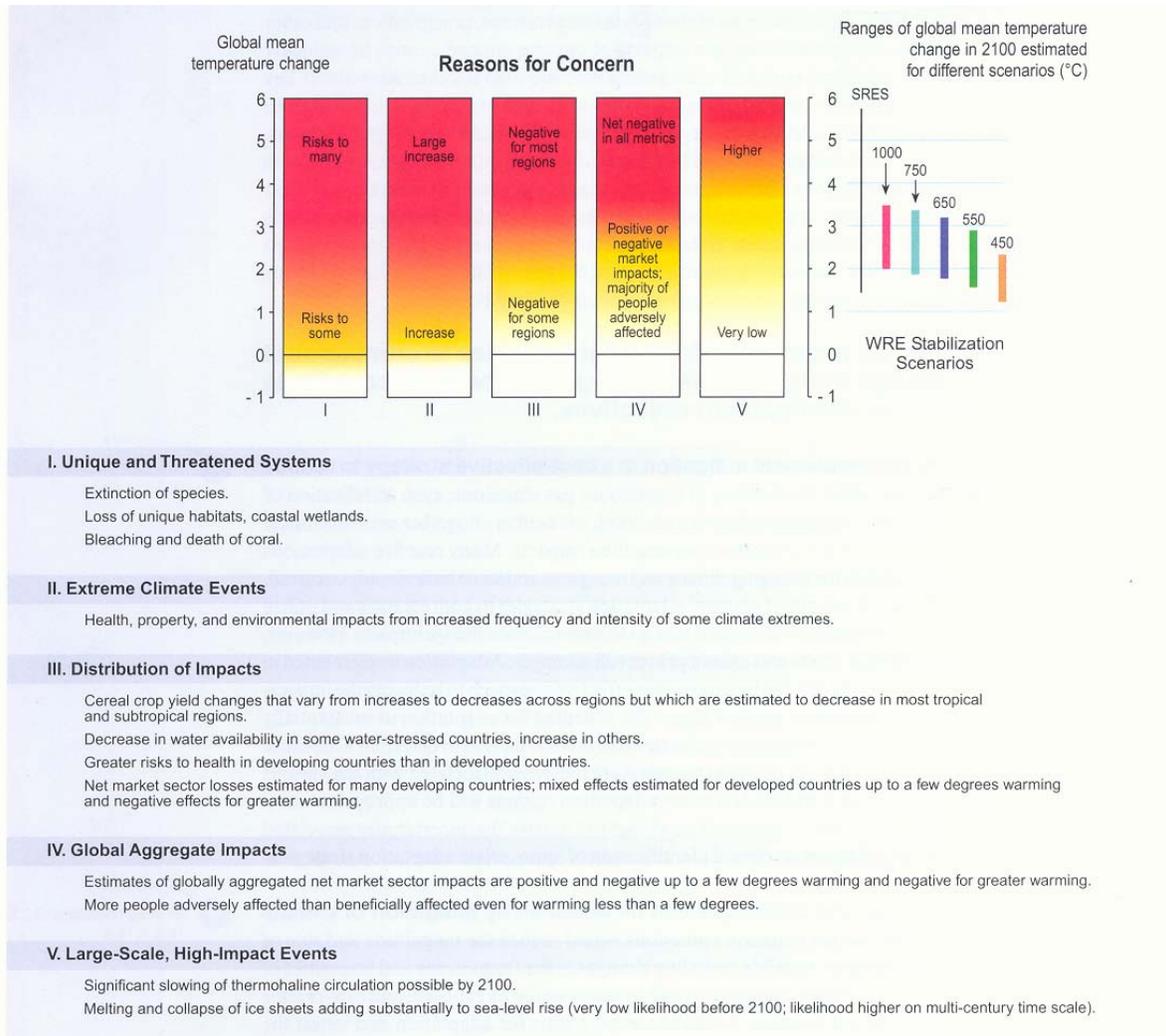


Figure 1-47. The risks of adverse impacts from climate change are depicted for different magnitudes of global mean temperature change, where global mean temperature change is used as a proxy for the magnitude of climate change. Estimates are for global mean temperature change by the year 2100 relative to the year 1990. White indicates neutral or small negative or positive impacts or risks; yellow indicates negative impacts for some systems or low risks; and red means negative impacts or risks that are more widespread and/or greater in magnitude. The assessment of impacts or risks takes into account only the magnitude of change and not the rate of change. Global mean annual temperature change is used as a proxy for the magnitude of climate change, but impacts would be a function of, among other factors, the magnitude and rate of global and regional changes in mean climate, climate variability and extreme climate phenomena, social and economic conditions, and adaptation. (Text and graph reprinted from IPCC, 2001, 103).

The IPCC's explanation makes clear that the intensity of the magnitude of impacts varies according to the extensity of CO2 levels and concomitant temperature increase. We have seen that Nordhaus and Boyer estimate around 2.5 degree C (4.5 degrees F) increase in temperature for the year 2100 under all scenarios. We also have good reason to believe that their estimate is conservative; at best, it seems to be low-end estimate. According to the IPCC, the threshold for significantly increasing the magnitude of damages is 3.5 degrees C (6 degrees F), though the threshold for natural systems and extreme weather events is much lower. Manstrandea and Schneider (2004, 572) approach Figure 1-47 this way.

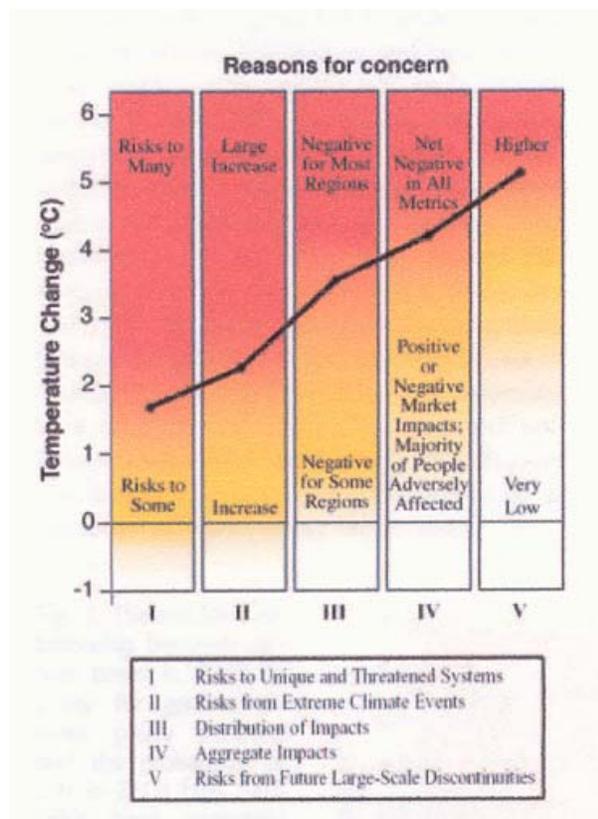


Figure 1-48. (Reprinted from *Science*, Vol. 304, p. 572)

For their cumulative density function (a probabilistic framework) for assessing dangerous anthropogenic interference Mastrandrea and Schneider take the *median* threshold for dangerous climate change to be 2.85 degrees C (5 degrees F). It also helpful to recall Figure 1-2, which shows that the difference between our present warm climate and the last major ice age is about 6 degrees C (10.8 degrees F).

The point is that as side (a) of the measure relation gradually increases so does the intensity and frequency of side (b), the magnitude of discrete events. But there are certain thresholds along the continuum of (a) that, if crossed, will trigger (b) much more intense, even catastrophic, impacts. Hegel's measure relation is a major issue in climate change -- determining thresholds or what are called "non-linear event." The standard example of a threshold, or limit, is water freezing. If a glass of water is at room temperature it can become progressively cooler until it reaches a certain limit, 0 degrees C, at which point it passes over from liquid to a solid state.

Dessai *et al* write that "there is no universally established methodology or process for deciding what constitutes a dangerous level of climate change, and for whom. However, implicitly or explicitly, researchers have suggested thresholds of climate change, or of the impacts of climate change, which they themselves designate as dangerous, undesirable, or to be avoided" (2004, 12). Below are examples Dessai *et al* give of danger measured through thresholds of physical and social vulnerability. Most of the examples are specifications of the risks listed by the IPCC in Figure 1-47. I will give the examples (from Dessai *et al*, 2004, 12) with their original sources to show that they have been independently verified.

Danger measured through threshold in physical vulnerability

1. Large scale eradication of coral reef system (O'Neil and Oppenheimer, 2002)
2. Disintegration of the West Antarctic Ice Sheet (Vaughan and Spouge, 2002)
3. Breakdown of the thermohaline circulation system (Rahmstorf, 2000). (We will discuss this below).
4. Qualitative modification of crucial climate-system patterns such as ENSO [which is responsible for the El Nino effect] and NAO [Northern Atlantic Oscillation] (Timmermann et al, 1999).
5. Climate change exceeding the rate at which biomes can migrate (Malcom and Markham, 2000)

Danger measured through threshold in social vulnerability

6. Irrigation demand exceeding 50 per cent of annual seasonal water usage for agriculture in northern Victoria, Australia (Jones, 2000)
7. Depopulation of sovereign atoll countries (Barnett and Adger, 2003)
8. Additional millions of people at risk from water shortage, malaria, hunger and coastal flooding (Parry et al, 2001)
9. Destabilisation of international order by environmental refugees and emergence of conflicts (Homer-Dixon, 1991; Barnett, 2003)
10. World impacts exceeding a threshold percentage of GDP (Frankhauser, 1995; Nordhaus and Boyer, 2000). (These are severe economic impacts on a global scale)

What makes all these thresholds dangerous is that, with all its feedback mechanisms, climate change may occur faster than we and other animals are able to adapt to it. Tol quantifies, for economic purposes, some of the health risks in number 8.

Region	Malaria		Schistosomiasis		Dengue fever	
OECD-A	0	(0)	0	(0)	0	(0)
OECD-E	0	(0)	0	(0)	0	(0)
OECD-P	0	(0)	0	(0)	0	(0)
CEE and fSU	0	(0)	0	(0)	0	(0)
ME	155	(112)	-64	(13)	0	(0)
LA	1,101	(797)	-114	(22)	0	(0)
S and SEA	8,218	(5949)	-116	(3)	6,745	(1,171)
CPA	0	(0)	-128	(25)	393	(68)
AFR	56,527	(40,919)	-503	(99)	343	(60)

Figure 1-49. Additional deaths due to vector-borne disease for a 1 degree C global warming. (Tol, 2003, 284). OECD = Organization for Economic Co-Operation and Development; A = Americas; E = Europe; P = Pacific; CEE = Central and Eastern Europe; fSU = former Soviet Union; ME = Middle East; LA = Latin America; S and SEA = South and South-East Asia; CPA = Centrally Planned Asia; AFR = Africa

Region	Cardiovascular – cold		Cardiovascular – heat		Respiratory	
OECD-A	-64.4	(4.4)	11.4	(5.9)	3.0	(9.7)
OECD-E	-99.8	(2.6)	11.7	(4.0)	-2.8	(5.7)
OECD-P	-13.1	(2.2)	3.5	(2.8)	1.0	(4.8)
CEE and fSU	-87.5	(5.2)	10.7	(4.4)	4.5	(11.0)
ME	-8.9	(1.3)	2.5	(0.4)	9.9	(2.6)
LA	-20.0	(3.5)	8.1	(1.8)	11.1	(7.0)
S and SEA	-63.8	(16.9)	17.5	(2.9)	141.2	(34.1)
CPA	-103.4	(21.7)	24.3	(4.6)	62.8	(44.4)
AFR	-18.2	(3.0)	4.7	(0.5)	24.8	(6.0)

Figure 1-50. Additional deaths (in thousands) due to cardiovascular and respiratory diseases for a 1 degree C global warming. (Tol, 2003, 294).

Figure 1-50 shows that there is some trade-off between reduced wintertime mortality and increased mortality due to heat stress. The trade-off is not much of one, however, as we

saw with the heatwave in Europe in the summer of 2003. The additional deaths due to malaria in Africa, dengue fever in southern and southeast Asia, and respiratory diseases in southern as southeast Asia are quite staggering given that they are projected for only a 1 degree C increase in global warming. Malaria has already quadrupled worldwide between 1995 and 2000. Today "mosquito-borne malaria kills at least 1 million people and causes more than 300 million acute illnesses each year. In Africa alone, malaria is killing about 3,000 children each day. 'Malaria kills an African child every 30 seconds, and remains a risk to the health of pregnant women and their newborns,' according to Carol Bellamy, executive director of the United Nations Children Fund" (Gelbspan, 2004, 122).

It is strange that although the West-Nile virus has received all the press in the United States no one has bothered to mention that the *cause* of its spreading is global warming. West-Nile is one of the many insect-borne diseases whose range is spreading due to increased temperatures. Moreover, "intensified flooding and droughts resulting from global warming," writes Paul Epstein of the Center for Health and Global Environment at Harvard Medical School, "can each help trigger outbreaks by creating breeding grounds for insects whose dessicated eggs remain viable and hatch in still water" (quoted in Gelbspan, 2004, 124).

Water shortage is already a silent epidemic. According to the WHO, each year 1 billion people have to resort to using potentially harmful water sources and 2 in 10 people in the world do not have access to fresh drinking water. With its droughts and water contaminating floods, climate change will only exacerbate this epidemic. In addition to water shortages, there is also potential for crop failure and malnutrition, especially in

undeveloped and developing countries. These countries simply do not have the infrastructure to cope with the impacts of climate change.

Climate change is already affecting affluent countries. Jeremy Leggett's *The Carbon War* traces the correlation between billion-dollar weather catastrophes (called "bill cats") and rising temperatures, as well as his own efforts to galvanize insurance companies into influencing climate change policy. He quotes a striking sentence from Munich Re's 1996 annual analysis of the global catastrophe bill. In 1996 the global insurance industry only suffered \$9 billion in losses, well below the figures for 1995 and 1994. Nevertheless, the report concluded: "According to current estimates, the possible extent of losses caused by extreme natural catastrophes in one of the world's major metropolises or industrial centres would be so great as to cause the collapse of entire countries' economic systems and could even bring about the collapse of the world's financial markets" (quoted in Leggett, 2001, 261). I think that European insurers share the sentiment expressed by a research scientist with regard to the astonishing number of increased disease incidence that has already occurred due to global warming: "We don't want to be alarmists, but we are alarmed" (Richard Ostfield, quoted in Gelbspan, 2004, 121).

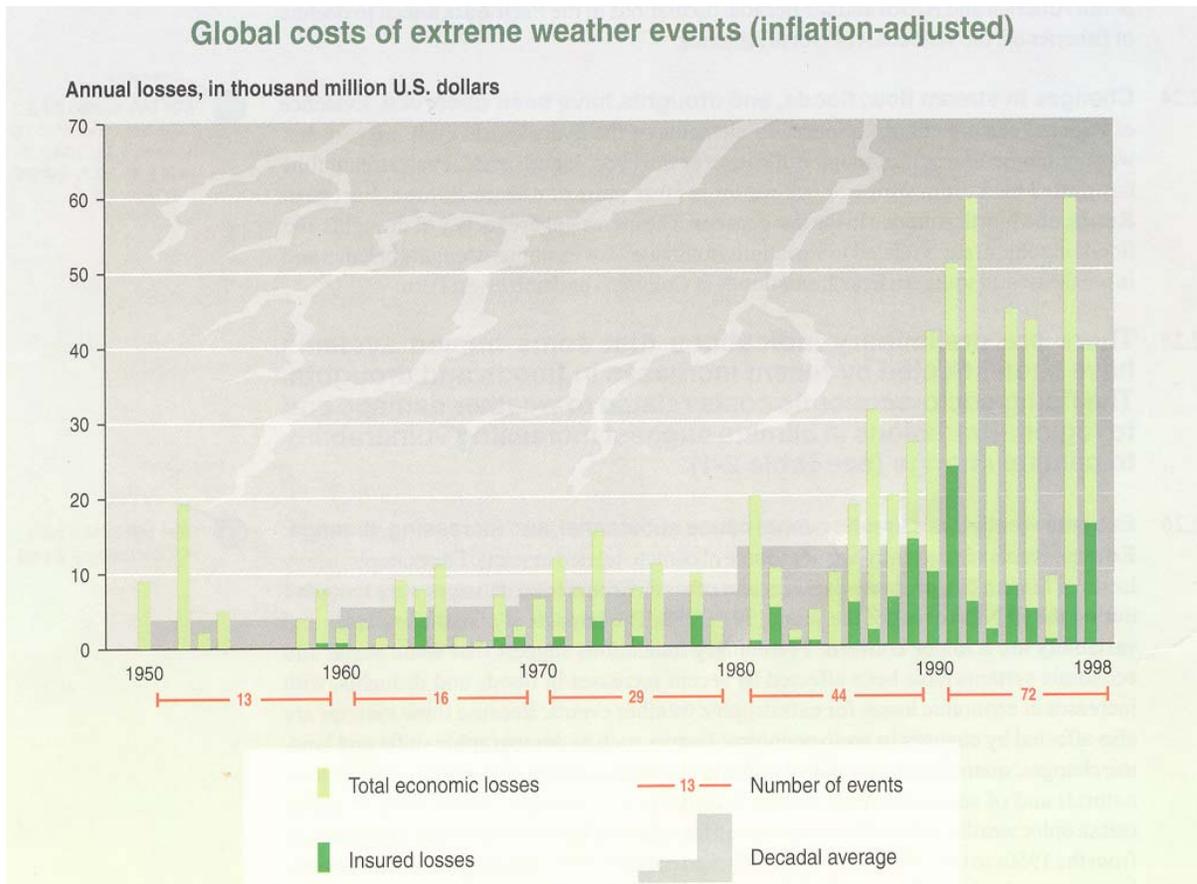


Figure 1-51. The economic losses from catastrophic weather events has risen globally 10-fold (inflation adjusted) from the 1950s to the 1990s. The insured portion of these losses rose from a negligible level to about 23% in the 1990's. The total losses from small, non-catastrophic weather events (not included here) are similar. Part of this increase in weather related disaster losses over the past 50 years is linked to socio-economic factors (e.g. population growth, increased wealth, urbanization in vulnerable areas, and part is linked to regional climatic factors (e.g., changes in precipitation, flooding events). (Text and graph reprinted from IPCC, 2001, 56).

Nodal Line of Measure Relations

A catastrophic or "non-linear" event is the question mark that looms large over climate change. At what point along the nodal line of measure-relations can something abruptly and unexpectedly occur; something that could not be discerned from the previous progression of the line? A catastrophic event will occur as a synergy of many

relations coming together and pushing a certain threshold beyond its limit. Hegel's explanation is, typically, more convoluted, but the basic idea is the same.

The relation *to itself* of the measure relation is distinct from its externality and alterableness which represents its quantitative aspect [side (a)]. As related to itself in contrast to these, it is an affirmatively present, qualitative foundation [side (a) joined with side (b)] -- a permanent material substrate which, as also the continuity of the measure *with itself* in its externality [side (a)] must contain in its quality [side (b)] the principle of the specification of this externality [side (a)] referred to above (367).

Materially existing individuals interact with each other according to their respective measure-relations. When the two sides of the measure-relation, (a) and (b), are put together, they form a *material* substrate. "They [the interactions among the measure-relations of material things] take place in *one and the same* substrate...measure develops other, merely quantitatively different relations which likewise form affinities and measures, alternating with those which remain only *quantitatively* different [those that do not experience a significant change in quality]. They form in this way a nodal line of measures on a scale of more and less" (367). The material substrate is the line, and the measure-relations are the various points along the line. It should be emphasized that a line is made up of many points. The measure-relations are points along a continuous line, and these points make up the line itself. This is the dialectical culmination of sides (a) and (b) of measure. Put differently, measure-relations are to their material substrate what points are to a line (more on which below).

As measure-relations gradually increase or decrease, quality fluctuates along with them. When a certain limit or point along the line is reached, a leap occurs and more than gradual qualitative change takes place.

Since the progress from one quality [to another] is in an uninterrupted continuity of the quantity [my emphasis], the ratios [or relations] which approach a specifying point are, quantitatively considered, only distinguished by a more or less. From this side, the alteration is gradual. But the gradualness concerns merely the external side of the alteration [side (a)], not its qualitative aspect [side (b)]...On the qualitative side,

therefore, the gradual, merely quantitative progress which is not itself a limit, is absolutely interrupted; the new quality in its merely quantitative relationship is, relatively to the vanishing quality, an indifferent, indeterminate other, and the transition is therefore a *leap* (368).

What separates two qualities is a certain limit or point on the gradual, continuous line of quantity, as illustrated in Figures 1-47 and 1-48. But some points along the line are more significant than others. Some points trigger a qualitative leap.

Although catastrophic events are inherently hard to predict, since thresholds are inherently hard to ascertain, there is one catastrophic event that is definitely in the pipeline. It is a shutdown of the thermohaline circulation system (THC). As part of the thermohaline circulation system (see Figure 1-52), the Gulf Stream is a circular flow of water, beginning in the Gulf of Mexico, that cools and sinks in the Northern Atlantic, where it begins its homeward path. The Gulf Stream keeps average temperatures in Europe around 15 degrees higher than they would be otherwise. The “conveyor belt,” as it is called, begins its flow back to the Gulf in the northern Atlantic because the salinity of the cool water makes the water dense. The dense water sinks and then flows back southward, underneath the warm upper currents. The salinity is in jeopardy. Russia’s three main rivers, each about the size of the Mississippi, are dumping more and more fresh water into the Northern Atlantic because of increased rainfall caused by global warming. "It is very likely that precipitation has increased by .5 to 1% per decade over most mid- and high latitudes in the northern hemisphere" (IPCC, 154). Add to that the melt-water from Greenland’s glaciers, which have been slowly melting in the last half-century. The wildcard in a possible THC shutdown is the Greenland ice sheet, which is located at almost the precise point where the salty water begins to sink. Should a chunk

of the ice sheet break off, or should a lake of melt-water form and burst through its dam, such a massive influx of freshwater would not bode well for the THC.

On this scenario, there are at least five nodal lines of measure-relations (relations among materially existing individuals) relating to one another to determine a sixth nodal line. Here is the summary.

(1) Increased greenhouse gases in the atmosphere

(2) Warming as the result of (1)

(3) Increased precipitation as the result of (2)

(4) Increased influx of fresh water into the northern Atlantic as a result of (3).

(5) Melting of the Greenland ice sheet as result of (2)

(6) If the salinity level of the water in the Northern Atlantic falls below a certain limit, as a result of every factor in 1-5 crossing a certain limit, the THC could abruptly shut down.

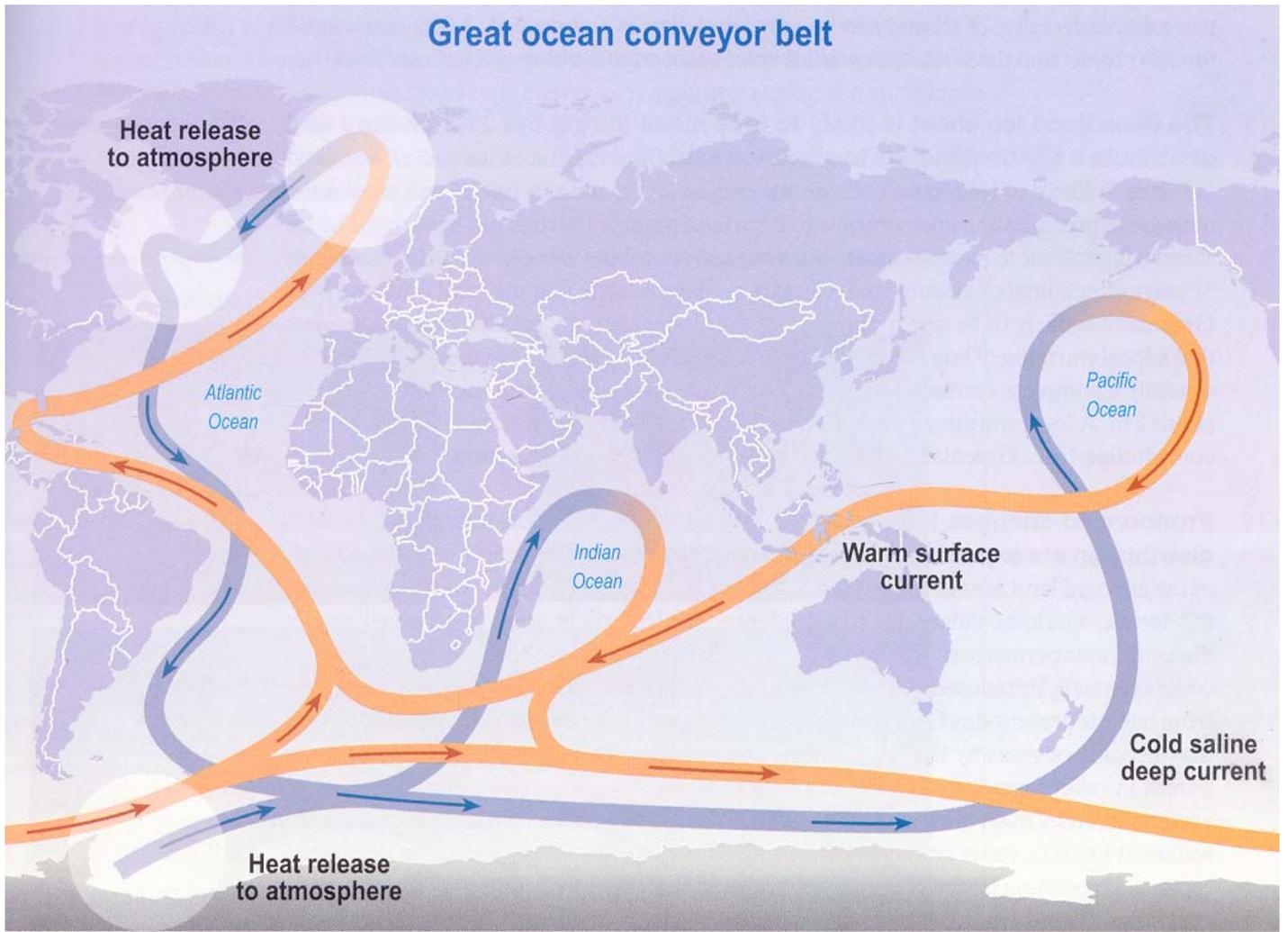


Figure 1-52. The water cools and sinks at the highlighted northernmost point in the Atlantic. Note the proximity of the Greenland ice sheet to this point.

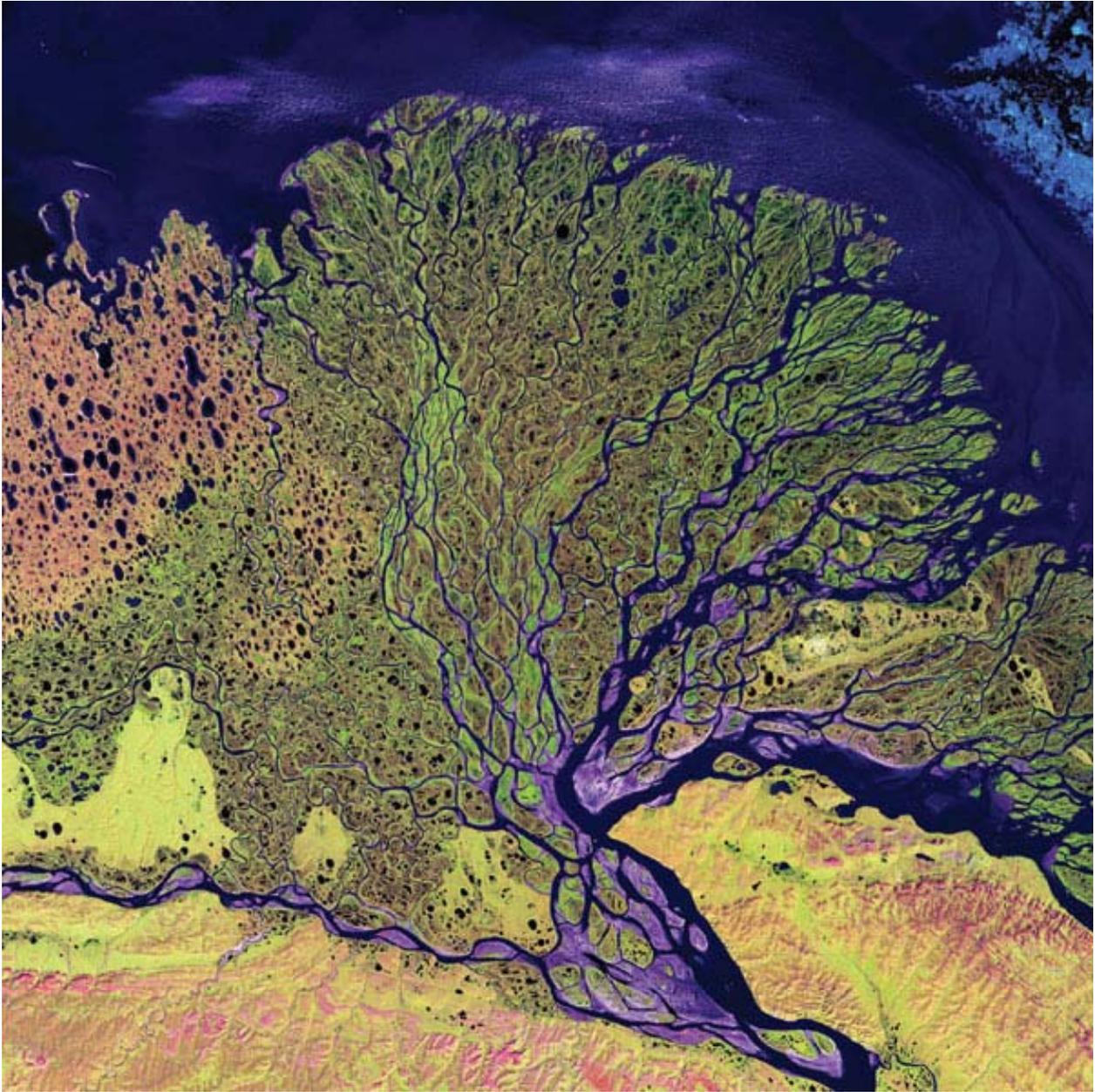


Figure 1-53. The vast delta of the Lena River, Russia, which is some 250 km wide. Stocker and Raible report that "large rivers such as this collect water from Eurasia and North America and discharge it into the Arctic seas. About half of the total volume delivered to the Arctic comes from the Eurasian river systems." They estimate that "discharge from Eurasian rivers may increase by 20-70% by the end of this century." There has already been a significant average increase in Arctic river discharge since the mid 1930s and "this trend was magnified by at least a factor of three during the last 30 years of the twentieth century." A climate model shows that "a comparison between simulations with and without greenhouse gases reveals that the increased discharge is clearly associated with warming induced by rising concentrations of greenhouse gases" (2005, 831). (Picture reprinted from *Nature* 434, p. 830).

The salinity level where the water sinks in the Northern Atlantic began to suddenly drop in the 1970's. Part of the Gulf Stream's flow has already decreased by 20% (Hansen *et al*, 2004, 954). The Gulf Stream has shut off in the past. On each occasion this coincided with decreasing temperatures, less rainfall, and glacial expansion. It is thought that the mini-ice-age in the eighteenth century was brought about by a significant slowing of the Gulf Stream. At that time the glaciers were still retreating, and a large melt "pond" formed in Canada around the Quebec, Ontario, and Hudson Bay region (that's just to the left of the bottom highlighted part of the Northern Atlantic in Figure 1-51, where the Hudson Bay dips down into Canada). The dam holding the meltwater burst and large amounts of freshwater flowed into the northern Atlantic. Since this occurred shortly before the onset of the mini-ice-age, the causal connection between the two events is highly probable. The Gulf Stream eventually recovered. We will not be so fortunate in a shutdown brought about by global warming since there is no way to reverse the effects of global warming.

If the conveyor belt were to abruptly "switch off," Europe would experience a massive temperature drop. By the British government's estimates, 1 in every 7 winters in Great Britain would be like the winter of 1962, the most punishing winter on record. Computer models show that a possible result of a significant decrease in temperatures, especially in Northern Europe, will greatly lessen the amount of rainfall in tropical regions. The Central American rain forests will turn into grasslands, just as the planet's lush forests did 6 to 8 million years ago. Southeast Asia's monsoon season will disappear, possibly leading to starvation, economic collapse, and mass migration. The northeast corridor of the United States could soon -- as in decades -- be under a glacier

due to dropping temperatures and snow being on the ground ten months of the year. In this feedback loop, global warming could lead to mass cooling. This is probably the most striking Hegelian example of how quantitative changes could lead to massive qualitative changes.

The IPCC reports that "the current projections do not exhibit a complete shutdown of THC by the year 2100. Beyond the year 2100, some models suggest that THC could completely, and irreversibly, shut down in either hemisphere if the change in radiative forcing [greenhouse gas buildup] is large enough and applied long enough" (IPCC, 84); that is, if global warming continues at a semi-rapid pace. Moreover, the more the flow *gradually* weakens, the more the Gulf Stream becomes susceptible to an *abrupt* shutdown. "Models indicate that a decrease in THC reduces its resilience to perturbations (i.e., a once-reduced THC appears to be less stable and a shutdown can become more likely)" (84). Not surprisingly, the THC has been a focal point of much scientific research. For details on the hydrological cycle and the influx of fresh water, see Stocker and Raible, 2005; and Curry, Dickson, and Yashayaev, 2003. For details on the THC itself see Hansen *et al*, 2004; and especially Clark *et al*, 2002.

A catastrophic event makes quantitative or economic analyses of climate change extremely, at best, difficult; at worst, it makes it impossible. The only thing that is certain is that as the temperature increases so does the probability of a catastrophic event. So again, the question is whether countries are willing to pay money up front in order to avoid the possibility of losing significantly more money. Figure 1-54 sums up this scenario.

Willingness to pay to eliminate risk of catastrophic climate change

	(1)		(2)	(3)	(4)	(5)		(6)
	Probability of catastrophic event		6 deg	Relative vulnerability	Expected loss if catastrophic event (% of GDP)	Willingness to pay to avoid catastrophic risk (% of GDP)		6 deg C
	2.5 deg	6 deg				2.5 deg C	6 deg C	
United States	0.012	0.068		1.0	22.1	0.45		2.53
China	0.012	0.068		1.0	22.1	0.45		2.53
Japan	0.012	0.068		1.0	22.1	0.45		2.53
OECD Europe	0.012	0.068		2.0	44.2	1.90		10.79
Russia	0.012	0.068		1.5	33.2	0.94		5.33
India	0.012	0.068		2.0	44.2	1.90		10.79
Other high income	0.012	0.068		1.5	33.2	0.94		5.33
High-income OPEC	0.012	0.068		1.0	22.1	0.45		2.53
Eastern Europe	0.012	0.068		1.0	22.1	0.45		2.53
Middle income	0.012	0.068		1.0	22.1	0.45		2.53
Lower middle income	0.012	0.068		1.5	33.2	0.94		5.33
Africa	0.012	0.068		1.0	22.1	0.45		2.53
Low income	0.012	0.068		1.5	33.2	0.94		5.33

Figure 1-54. Column (4) is calibrated so that expected global loss is 30% of GDP when the GDP's different regions are weighted by their relative vulnerabilities in column (3). The willingness to pay for each region in columns (5) and (6) assumes a rate of relative risk aversion of 4, the probabilities in columns (1) and (2), and the expected loss in column (4). (Nordhaus and Boyer, 90).

Europe and India stand to lose the most in the case of a catastrophic event, and low and low middle income countries will also be greatly affected. The world's largest emitters, the United States and China, are at the low end of the scale. Figure 1-54 demonstrates the difference between gradual impacts of climate change, as compared with a catastrophic impact along the gradual continuum. Figure 1-55 is also an economic nodal line.

Summary of impacts in different sectors: impact of 2.5 degree warming (positive numbers are damages; negative numbers are benefits; impacts measured as percent of market GDPs)

	Total [2.5 degree]	Agriculture	Other vulnerable market	Coastal	Health	Nonmarket time use	Settlements	Catastrophic impact	
								[2.5 degree]	[6 degree]
United States	0.45	0.06	0.00	0.11	0.02	-0.28	0.10	0.44	2.97
China	0.22	-0.37	0.13	0.07	0.09	-0.26	0.05	0.52	3.51
Japan	0.50	-0.46	0.00	0.56	0.02	-0.31	0.25	0.45	3.04
OECD Europe	2.83	0.49	0.00	0.60	0.02	-0.43	0.25	1.91	13.00
Russia	-0.65	-0.69	-0.37	0.09	0.02	-0.75	0.05	0.99	6.74
India	4.93	1.08	0.40	0.09	0.69	0.30	0.10	2.27	15.41
Other high income	-0.39	-0.95	-0.31	0.16	0.02	-0.35	0.10	0.94	6.39
High-income OPEC	1.95	0.00	0.91	0.06	0.23	0.24	0.05	0.46	3.14
Eastern Europe	0.71	0.46	0.00	0.01	0.02	-0.36	0.10	0.47	3.23
Middle income	2.44	1.13	0.41	0.04	0.32	-0.04	0.10	0.47	3.21
Lower middle income	1.81	0.04	0.29	0.09	0.32	-0.04	0.10	1.01	6.86
Africa	3.91	0.05	0.09	0.02	3.00	0.25	0.10	0.39	2.68
Low income	2.64	0.04	0.46	0.09	0.66	0.20	0.10	1.09	7.44
Global (a)									
Output-weighted	1.50	0.13	0.05	0.32	0.10	-0.29	0.17	1.02	6.94
Population -weighted	1.88	0.17	0.23	0.12	0.56	-0.03	0.10	1.05	7.12

Figure 1-55. Population-weighted global average is weighted by population in 1995. (Nordhaus and Boyer, 91).

The Measureless

There is a sense in which the impacts of climate change cannot be measured or predicted. If the economic impact of a catastrophic event cannot be quantified, one can only shudder at the qualitative human and environmental impact. Whether the impacts of climate change are gradual or sudden (or both) deaths can be tallied, as can the number of people without water or with certain diseases, or species going extinct, or the environment being degraded. But the suffering inflicted by global climate change on humans and other animals is measureless. In another sense, the interlocking relations that comprise the one system of global relations are also measureless. The latter more closely approaches Hegel's category of the measureless.

Materially existing individuals form relations with one another according to their respective measures via a *measureless* substrate. The substrate is that in which all

measure-relations are embedded. As pointed out above, new relations among material things are constantly being formed, and these relations form new measures, the new measures form still more relations, which create new measures, and they form...and so on. What ties all these relations together? What, in other words, is the measure of measure? Hegel's response is that the measure of measure is measureless. "The quantitative reference beyond itself to an other which is itself quantitative perishes in the emergence of a measure relation, of a quality; and the qualitative transition is sublated in the very fact that the new quality is itself only a quantitative relation. This transition of the qualitative and quantitative into each other proceeds on the basis of their unity, *and the meaning of this process is only to show or to posit a determinate being of such a substrate underlying the process, a substrate which is their unity*" (372 -373, my emphasis).

The measureless substrate is *that within which* all the above mentioned measure-relations occur. It is what ties these relations together and unifies them. The material substrate is also inseparable from its measure-relations, just as a line is inseparable from all its points since a line is formed out of points. Here's another example.

I think that it is fair to characterize the many systems of relations that relate to one another in order to form the one infinite (in Hegel's sense) system of relations that brings about global climate change as incredibly complicated. Its complicated nature is where the measureless comes in. Think of all these relations, in all the various ways they affect one another, as a tangled up ball of twine. All the ways which the twine is entangled-- zigzagging, looping, knotting, crossing over itself -- can be thought of as the twine's system of relations, while the twine itself, its physical composition, is the material

substrate of the system of relations. Imagine, also, that it is impossible to disentangle this ball of twine. In this case, the twine is measureless because there is no way to straighten all the twine out enough to measure it. You can, however, measure certain loops or sections of the twine -- just not all of the twine at once. So the material substrate, as a whole, is measureless, but some of the various relations into which the twine enters can be measured, for they are "measure-relations."

Any time you fiddle with the twine, say by trying to disentangle it, you are altering its system of relations. But even though you may rearrange the twine many times over you still have not changed the basic material substrate of the twine. It's the same twine, only rearranged in a different way. You have altered the *states* of the twine but not the material composition or substrate of the twine itself. The same applies to climatic processes. The 33 or so ice ages, snowball earth, greenhouse warming, increased and decreased precipitation, etc. are *states* of a climate on earth that has been in perpetual motion for billions of years.

So relations among materially existing individuals are, in Hegel's terms, states of a measureless material substrate. "Now such relations are determined only as nodal points of one and the same substrate. Consequently, the measures and the self-subsistent things posited with them are reduced to *states*. The alteration [of the substrate] is only a change of a *state*, and the *subject* of the transition [the substrate] is posited as remaining the *same* in the process" (373). Or again: "it is as yet only a substrate, a *material* [my emphasis], and for its differentiation into totalities, i.e., into differences embodying the nature of the unchanged substrate, it is solely dependent on the external, quantitative determination which shows itself at the same time as a difference of quality" (374).

Although the measure relations *of* the substrate fluctuate and change, the substrate itself remains unchanged. Hegel also holds that the substrate is "dependent on" its states or external determinations. This is just another way of saying that the substrate is only found **in** its states or external determinations.

Here is another example to illustrate this point. Gas, liquid, and solid are all states of H₂O governed by measure-relations. Even though the states of H₂O change as their measure-relation changes, the basic molecular structure of H₂O remains unchanged across its various states. In this sense, H₂O is a material substrate. But H₂O is only found **in** a certain state -- gas, liquid, or solid. Therefore the substrate is inseparable from its external state or determination. The same holds for the twine. Even if you were to straighten it out, this would only be another state or external determination of its material composition. By the same token, global warming is a state of the climate just as much as an ice-age is a state of the climate. Earth's basic climatic processes have remained the same for billions of years. The external states or determinations by these processes have, however, varied considerably -- from sweltering greenhouse heat, to snowball earth, to the current temperate climate.

The Becoming of Essence

To say that the substrate remains the same while its external determinations vary is to say that the substrate is indifferent to its determinations. In this section, Hegel does quite a bit of dialectical maneuvering to express this thought. Something still has to hold together, or unify, all the external determinations and states of the substrate. That something is nothing other than the substrate itself. The substrate is a "negative unity."

The negative unity of the substrate operates in the same way that the negative unity of the abstract category "cat" is responsible for the similarity among all species of cats -- lions, tigers, pumas, lynxes, bobcats, mountain lions, and my two cats. The difference is that at this point the substrate is not yet *explicitly* **in** its various determinations in the same way that the abstract category "cat" is found only **in** its determinations. At this point, the substrate is only *implicitly*, or immediately or immanently, in its external determinations.

The following passage sums up where we currently stand.

Now these repelled determinations do not possess themselves, do not emerge as self-subsistent or external determinations, but first, *as moments* belonging to the *implicit* unity, they are not expelled from it but are borne by it as the substrate and are *filled solely by it* [my emphasis]; secondly, as determinations which are immanent in the *explicated* unity, they *are* only through their repulsion from themselves. The being of the determinations is...now a sheer *positedness*, the determinations having the fixed character and significance of being related to their unity, each consequently being related to its other and with negation; this is the mark of their relativity (384).

The measure-relations are external determinations, or moments, of an underlying substrate. They are the "positedness" of the substrate, which constitutes the implicit unity among the relations. The important point to bear in mind is that the negative unity of the substrate is just that -- negative, even though Hegel claims that the substrate is material and its moments are "filled solely by it." We turn now to Book II and how this implicit unity becomes explicit; how the immediacy becomes mediated; or how the substrate becomes fully embodied **in** its moments. Along with that, we turn to new aspects of climate change.

CHAPTER IV

THE DOCTRINE OF ESSENCE

"Climate change is as much an economic issue as it is an environmental issue. We must ensure that our global competitiveness is not compromised. Let's not allow our nation to be duped into assisting our competitors in the global market to achieve competitive advantage under the subterfuge of environmental policy" (Senator Craig (R-ID), in debating "The Climate Stewardship Act").

"It will simplify the approach to the concepts of the sphere of Essence if one stresses that they are concepts of *disposition*. What enjoys *Gesetzseyn* [posited being] in something else is what is *virtually, dispositionally* present in it. While the concepts of the sphere of Being deal only with what *manifestly* is, the concepts of the sphere Essence also with what is *latent*, with what *would* or *could* be in certain circumstances (Findlay, 1958, 220).

Essence as Reflection Within Itself

Book II marks a new beginning. The opening chapter of Book II, "Illusory Being" (*Schein*), is also, to my mind, the most difficult part of the *Science of Logic*. Most of the difficulty stems from the fact that from the very start the "Doctrine of Essence" is a new way of thinking. Gone are the simple external relations of Quality and Quantity in the "Doctrine of Being." These relations have developed into something much more complex.

A large part of Book I was devoted to emphasizing that external relations constitute the internal nature of something; whether that something is the climate system, economic processes, or the molecule carbon dioxide. Book II takes this truth as axiomatic. It starts from the notion that external relations have already been internalized. And the new relations that arise continue to be internalized. In the opening section,

"With What must the Science Begin," I characterized the movement of the *Logic* as "swallowing up" its presuppositions, or external relations, then coming into new relations, then swallowing these up. Essence, as the title of Section One states, is "Reflection- Within-Itself." The difference between essence and quality is that in essence the external relations are no longer external: they are fully incorporated into something. In Hegel's vernacular, this means that essence is reflection-within-self. Essence has "swallowed up" the relations of quality and quantity.

The opening chapter, "Illusory being," describes how this process takes place. There is sort of a skeleton key to this chapter. Once you learn to use this key you will be able to unlock every complexity in the chapter. The key is: essence is negation of negation and as such always *starts from* a negation. When negation of negation first appeared in the category "Something" we characterized it this way. That to which C02 is most closely related -- C0, C202, C20 -- is the non-being of C02, or the negation of C02. Negate this negation and we arrive at the positive quality C02. The selfsame principle is at work in essence, yet on a more specific level. As we know, the content of the *Logic* becomes more determinate as its negations become more specific. The main thing to bear in mind is that in essence one always starts from a negation and then negates that negation. Essence is the *movement* from one negation to the other.

At the end of the chapter Hegel sums up the difference between quality and essence.

Because being, which supports quality, *is not equal to the negation* [my emphasis], quality is unequal within itself and hence a transitory moment vanishing in the other. The determination of reflection, on the other hand, is positedness *as* negation, negation which has its negatedness as its ground, it is therefore not unequal within itself, and hence is essential (407).

To say that quality "is not equal to the negation" is to say that quality

does not fully incorporate or absorb that to which it is externally related. If quality did so, it would not be possible to change quality by altering its external relations. This is why Hegel claims that quality is "transitory." Quality still has its being outside of itself, in the form of external relations. For this reason, it needs to be further developed. The relations need to be fully incorporated **within** something. This development is reflection-into-self, in which "the determinateness of reflection is *the relation to its otherness within itself*" (408). Reflection-into-self is simply the completion of the notion that external relations are **in** something, as is the case with CO₂, the climate system, and economic relations.

Quality, through its relation, passes over into an other; in its relation its alteration begins. The determination of reflection, on the other hand, has taken its otherness back into itself. It is *positedness*, negation, which however bends back into itself the relation to other, and negation which is equal to itself, the unity of itself and its other, and only through this is an *essentiality*...as reflection-into-self it is...infinite self-relation (408).

Infinite self-relation is of course a self-enclosed system whose components, in their relations to other components, mutually interact through a system of relations. Described in Hegel's manner, each component "has taken its otherness back into itself." Since "its otherness" is its negation, each component of the system has negated its negation by fully incorporating within itself its relations to the other components. This would be the ideal case in the feedback loop shown in Figure 1-13 if we were to internalize the greenhouse externality; if we were, as Hegel would say, to negate our negation of the atmosphere's capacity to relay heat back to space. Here, too, we start with a negation, and the task is to negate this negation by bending our own external manifestations back into our sphere of activity. This is accomplished through the feedback in Figure 1-13. Enacting climate change policy through socio-economic paths would lessen emissions and concentrations, which would in turn mitigate climate change,

which would in turn lessen impacts on human and natural systems, which would in turn affect socio-economic paths, which would in turn... Essence is the fruition of the notion that each component has the other components built into it -- essence "bends back into itself the relation to other."

We should now consider how essence develops from measure. On the big metaphysical picture, essence is the ground of all that exists just as the material substrate is the ground of measure-relations. In fact, the material substrate is to measure-relations what essence (*qua* ground) is to all that exists. This is because everything that exists is determined by measure-relations; relations which are grounded by a material substrate. The relation between on the one hand, the material substrate as a ground and, on the other hand, measure-relations/all that exists is an infinite self-relation in that each side automatically entails the other side. That is, each side positively "exists" only as a negation of the other side, just as each component in the feedback loop in Figure 1-13 exists only in having its relations to the other components built into it.

The material substrate turns into what Hegel calls the "essential" and its measure-relations turn into the "inessential." Measure-relations are inessential because they are always changing and forming new relations. The material substrate is essential because it remains the same throughout the various changes in its measure-relations. As Hegel phrases it, the material substrate is the "base" of measure-relations (394). The relation between the two is "illusory being." It is important to recognize that illusory being is the relation between the essential and inessential. It is not, by itself, either one of these. Measure-relations point toward something that appears to be separate from them, something more fundamental and essential than their ever changing relations, in the sense

that measure-relations are merely states of a more fundamental substrate or ground. Measure-relations are purportedly the phenomena of a deeper reality. The latter is the unchanging material substrate.

What this view fails to realize is that measure-relations and the material substrate, the inessential and the essential, are the same thing -- "the same content can therefore be regarded now as essential and again as inessential" (395). Illusory being and the deeper reality are the same content looked at in two different ways. The content is the material substrate that is carved up by measure relations.

A simple example might clarify how the material substrate and its measure-relations develop into the movement of essence. Suppose you slice a loaf of bread two different ways, (a) and (b), as shown in Figure 2-1.

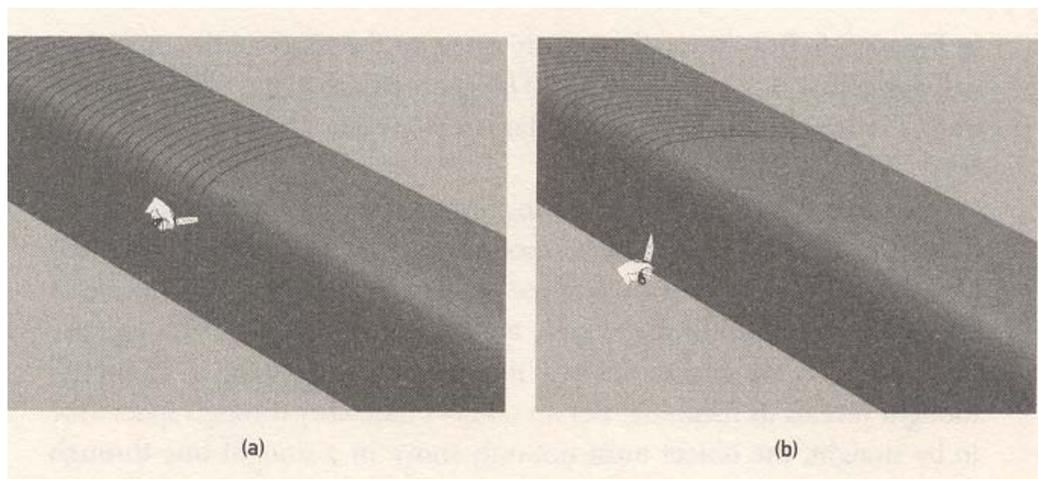


Figure 2-1. Sliced bread. (Reprinted from Greene, 2004, 59)

(a) shows the bread sliced from one angle, (b) from another angle. (c) would be

reverse angle of (b). Suppose, also, that (a) through (y) represent various ways in which you can slice one loaf of bread, including zig-zags, slicing down the middle, and what not. (z) represents a totally unsliced loaf, as partially shown in Figure 2-1.

Now, according to the distinctions introduced above, (a) through (z) are the inessential, changing states of the bread. Even (z) is a state of the one loaf of bread; the state of being unsliced. (a) through (z) are the changing measure-relations or states of the essential material substrate, the one loaf of bread. As Figure 2-1 shows, when you slice the bread in different ways you change the one loaf of bread. So in carving up the material substrate in a different way, in changing its measure relations, you change the material substrate itself. This is what Hegel means in claiming that the essential and inessential are the same content. The measure-relations are not phenomena of a deeper reality; they are the deeper reality. Measure-relations are relations *of* a material substrate just as (a) through (z) are different ways *of* carving up the material substrate of a loaf of bread.

Unlike the relations of quality, then, in altering measure-relations you are not merely altering the external determinations of the material substrate. Strictly speaking, the material substrate has no external determinations. The material substrate *is* its measure-relations, or is "equal to" its measure-relations.

The one loaf of bread (the material substrate) is determined by how it is carved up (its measure-relations). In other words, there is no material substrate without its measure-relations and there are no measure-relations without a material substrate. Each side presupposes the other. Thus "essence is characterized as essential [the one loaf of bread, the material substrate] only relatively to what is unessential [how it is sliced, or

not, in a-z]" (395). So although measure-relations and the material substrate are the same content we can still distinguish between them. We can, in principle, separate out the loaf of bread from all the ways in which it can be sliced.

This is the simple beauty at the heart of Hegel's complex account of essence. There cannot be a loaf of bread without it being sliced in a certain way, or not (z). And there are no various ways to slice the bread (what Hegel calls "determinations") without the "base" material substrate of a loaf of bread. Each side automatically entails or presupposes the other side.

For Hegel, the only way to arrive at one side is by negating the other side, that is, by negating a prior negation. To arrive at, say, the material substrate of a loaf of bread you have to start with its negation, one of the 26+ different ways in which it can be sliced up (or not), and then negate this negation. To arrive at (a) through (z) you have to start with one loaf of bread and then negate this negation by slicing it (or not) in one of 26 different ways. Essence is the relation between the one loaf of bread and the various ways it can be sliced (including (z)). As we can see, the two negations are "equal to each other" in that they share the same content -- the one loaf of bread.

The only way to arrive at something positive is through two negations. The *movement* from one negation to the other is essence, or infinite self-relation. A passage from the subsection "Reflection" expresses this.

Consequently, becoming is essence, its reflective movement is the *movement of nothing to nothing, and so back to itself*...this, to be the negation of a nothing, constitutes being. Being only *is* as the movement of nothing to nothing, and as such it is essence; and the latter does not *have* this movement *within it*, but is this movement as a being that is absolutely illusory, pure negativity, outside of which there is nothing for it to negate, but which negates only its own negative, which latter *is* only in this negating (400).

This is about the clearest passage in the chapter on illusory being. Since each side presupposes the other, essence is the ceaseless movement between two poles that negate each other: (1) the material substrate of the loaf of bread and (2) the various ways it can be sliced. A loaf of bread (one pole) only comes as sliced or unsliced (the other pole). The same applies to the examples from measure. Twine (one pole) only comes as straight, tangled up, or wound around something (the other pole). The material substrate is inseparable from its various determinations, though we can distinguish between the two. Try imagining twine as not taking on one of these determinations or try imaging a loaf of bread as separate from its determinations, as not being sliced in a certain way (including (z)). You can't. The distinction between "climate" and "weather" is also an instance of this relation. Climate is long-term processes based upon weather patterns. The weather constantly changes; the climate remains relatively constant throughout these changes. Climate is why it is balmy in the tropics and freezing in Siberia. Weather is variations in climate. In Hegelian terms, weather is a "determination" of climate. In statistical terms, climate is the mean; weather is the deviation from the mean. As the saying goes, 'climate is what you expect, weather is what you get.' The loaf of bread, the twine, and the climate are one pole of essence that presupposes the other pole, its various determinations. The various determinations, in turn, presuppose the other pole. Essence is, in this manner, reflection-within-itself.

We can now put the finishing touches on the line of thought that we began at the end of measure, where we claimed that the material substrate and its determinations must exhibit reflection-into-self in the same way that the category "cat" is reflection-into-self. That which carves up a certain chunk of material reality known as "cats," the essence of

cats, is the movement from the category "cat" to all materially existing cats and, equally, the movement from all materially existing cats to the category "cat." The category "cat" is the "negative unity" of materially existing cats. If we were to take every living cat on the planet and line them up in a huge field (and get them to sit still) we would see how the abstract category "cat" carves up the material substrate of physical reality in the same way that slicing a loaf of bread carves up the material substrate of the bread. Just as one loaf of bread and the various ways it can be sliced (including (z)) negate each other, so does the category "cat" and its materially existing individuals. Each is the negation of the other and -- strange as this may sound -- the positive existence of materially existing cats is the movement of "nothing to nothing, and so back to itself." Concrete, materially existing cats are the negation of their negation, the abstract category "cat"; and the abstract category "cat" is the negation of its negation, concrete, materially existing cats. Such is the essence of cats. This is how the category "cat" is **in** materially existing individuals or, what amounts to the same thing, how the category "cat" slices up natural reality. As I argued in the Introduction, all logical categories and their surrogates, natural categories, slice up material reality in this way in a more or less unified form. Since categories are logically prior to their phenomena, without the category "cat" there can be no materially existing cats. But equally, without materially existing cats there is no category "cat." Once again, negation is "equal to itself."

We have yet to cover the three types of reflection in illusory being -- positing, external, and determining reflection. Now that we have a general understanding of essence, I want to bring both Marx and climate change back into the picture in order to apply the *Logic*, as Lenin advises. The chapter on illusory being, and Hegel's Doctrine of

Essence in general, had a profound effect on Marx's analysis of how capital works (see Meaney, 2002; Smith, 1990; and Uchida, 1988). Reviewing Marx's account will help illuminate Hegel's three types of reflection.

Figures 2-2 and 2-3 are rough schematics of the movement of capital through positing, external, and determining reflection. Marx's account is obviously much more nuanced. I am only portraying the general picture.

→ CAPITAL →

→ Profit → Wealth →

→ wages for labor → means of production → exchange value of coal (market price of commodity) →

→ human labor to extract coal → means of production → use-value of coal (energy) →

→ CAPITAL →

CIRCULATION: money-form

PRODUCTION: material substratum

Figure 2-2. The circular circulation of capital. Capital is increased, money is made, only because capital is in constant circulation, just as essence is in constant movement. The bright green arrows correspond to Hegel's 'positing reflection' in that (a) capital presupposes itself in reproducing itself, and (b) the movement of capital is circular. The red print is the material substratum of capital: the physical labor by workers using machines to extract a naturally occurring substance formed by geological processes over millions of years. The use-value of the coal is determined by its physical properties. The blue print is the money-relations among the material substratum. Workers must be paid enough to allow them to keep working; the means of production must be purchased; and the coal must be exchanged for money in being sold at market price. The grey print of profit and wealth come much later in Marx's analysis. Wealth is the accumulation of profit. Technically, wealth does not return into production and circulation, nor does profit have to, though both are created through production and circulation. Both, for example, can be used to fund elected representatives so that more profit and wealth can be created through production and circulation. The production and circulation phases of capital are the 'external reflection' of capital. They are the external reflection of capital in that they are capital, and at the same time they are the outward manifestations of capital. Equally, capital is the external reflection of production and circulation in the forms of profit and wealth. Capital *determines* its forms of circulation and production, and production and circulation *determine* capital in that they bring about profit and wealth. Such mutual determination is Hegel's 'determining reflection.'

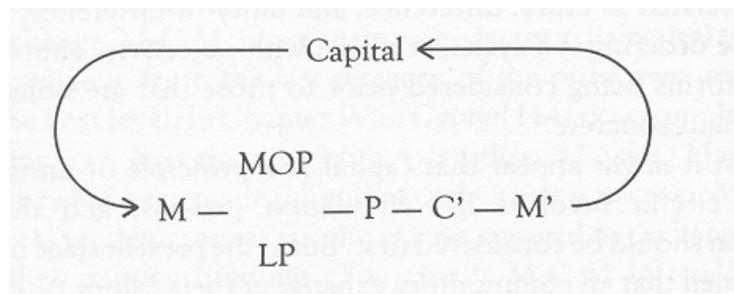


Figure 2-3. The circular circulation of capital. M = money; MOP = means of production; LP = labor power; P = product; C' = commodity; M' = money. In this simpler version, capital returning to itself through the process $M \rightarrow M$ is the 'positing reflection' of capital. Capital posits, or *presupposes*, the various moments of production and circulation. As such, capital is 'externally reflected' in its determinations. Capital determines $M \rightarrow M$ (with the left loop), and $M \rightarrow M$ determine capital (right loop). This is Hegel's "determining reflection." Thus capital returns to itself by presupposing, or positing, its external reflections, through which it determines itself. $M \rightarrow M$ is the illusory being of capital; they are the *external reflection* (or phenomena) of capital. Equally, though, capital is the illusory being of $M \rightarrow M$; capital is the phenomenon of more fundamental processes. (Figure reprinted from Smith, 1990, 100).

Figure 2-2 is meant to emphasize that circulation of capital, as well as profit and wealth, is rooted in material reality. The red, blue, and grey are all "moments" of capital. In Hegelian terms, capital negates itself and enters into these moments, and then negates these negations and returns to itself. Capital's return into itself or, more appropriately, reflection-within-self, is clearly shown in Figure 2-3.

There is a certain enigma, called "the Rhodus problem," that Marx is trying to solve through the circular movement capital. How can you start with a given amount of capital and then end up with a greater amount of capital when only equivalents are exchanged? Marx's solution to the Rhodus problems concerns Hegel's three forms of reflection.

To understand how this works, imagine that your billionaire aunt dies and leaves you \$100 million. Upon learning that coal companies have \$80 million to spend on

funding elected representatives, you decide to start a coal company. You take your \$100 million and buy land, build mines, buy machines (means of production), hire labor power, salespeople, etc. The coal is produced and you sell it on the market for \$20 million. Some of this money will have to go back into the means of production, wages, and so forth. After several runs through the cycle, you will have made back your \$100 million. After a while, your profit will accumulate to the point where you have amassed considerable wealth.

How is it that you are able to start with \$100 million and eventually end up with so much more than \$100 million? Simple. Capital negates itself by entering into its external reflections in the form of production and circulation; capital determines itself through these reflections (they generate profit and wealth); then capital returns to itself by negating its determinations. Capital must keep going through this cycle of positing its moments of production and circulation, entering into these external reflections, through which it determines itself, and then returning to itself, if you are to make any money from your coal business (see Marx, 1953, 254-256 his more specific, Hegelian, account of this process). To appreciate the complexity of Marx's analysis, we would have to follow the \$100 million dollars through all the forms of production and circulation. This is beyond the scope of our discussion. The general idea should be clear.

It is also worth noting that the German word for 'to posit' is *setzen*. 'To presuppose' is *voraussetzen*, literally 'to suppose before,' or 'pre-posit.' This translational nuance explains the circular movement of essence. One must always start from a negation. A negation must always be a negation *of* something. What this negation is a negation *of* is that which is presupposed or pre-posit. As Figures 2-2 and 2-3 show,

capital presupposes physical labor, material means of production, use-value, exchange value, prices, the market, and so forth, while all these things presuppose capital. Uchida observes that

Capital posits the presuppositions (*voraussetzung*) of its continued existence as a result of the activity of capital itself. Therefore what is posited (*das Gesetzte*) is the same as what is presupposed (*vorausgesetzt*). This order -- from presupposition to positing (*Setzung*) to what is posited or is resultant -- forms a circulation. In that way, the self-reproduction of the bourgeois economy shares a circular logic with Hegel's 'positing reflection' (1989, 68).

Positing reflection is *circular* -- the beginning is the end and the end is the beginning (represented by the bright green arrows in Figure 2-2 and the loop in Figure 2-3). You start with \$100 million of capital, send it through the loop, and then end up with more capital, to the tune of a 20+ % profit. "This immediacy which is only as return of the negative into itself, is that immediacy which constitutes the determinateness of illusory being and which previously seemed to be the starting point of the reflective moment. But this immediacy, instead of being able to form the starting point is, on the contrary, immediacy only as return or as reflection into self" (401). Capital and its moments are reflected into each other. As noted, each side presupposes the other and each side is the "illusory being" of the other side.

Capital is "externally reflected" in labor, the means of production, commodities, use-value, exchange value, prices and so forth. And these are, in turn, "externally reflected" in capital. To understand the latter, you need only bear in mind that labor, the means of production, use-value, exchange value, prices, and so forth are reflected **in** the profits that emerge at the end point of the circulation of capital. To understand the former, you need only consider that money is worthless unless it is externally reflected **in** something else; unless it can be exchanged for something else, whether that be

commodities, labor, means of production, etc. One need only go to the store and see a price tag on something to understand how money is externally reflected **in** commodities. It is also in this sense that money is a qualitative quantum that is externally reflected **in** commodities, labor, etc.

"Determining reflection" caps off positing and external reflection. "Determining reflection is in general the unity of *positing* and *external* reflection" (405). The \$100 million of capital you put into coal production determines the labor to be done, the means of production, and wages for labor, while the market determines price and exchange value. All these factors, in turn, determine the fate of your capital -- whether you achieve over 20% profit. So capital both determines and is determined by production and circulation. Determining reflection means *mutual* determination. And mutual determination is negation of negation or reflection-within-self.

True to form, we have ended this section where we began: infinite self-relation. The system of relations depicted in Figures 2-2 and 2-3 exhibit exactly the same structure as the feedback loop in Figure 1-13. In fact, Figures 2-2 and 2-3 represent the "socio-economic pathways" of Figure 1-13.

Essentialities or Determinations of Reflection

Chapter 2 of the Doctrine of Essence contains the core of the dialectical movement of the *Science of Logic*. The core is the relation between identity and difference. In our example with the loaf of bread we asserted that the different determinations of the loaf -- the different ways it is sliced -- is inseparable from the one loaf of bread, the material substrate of bread. In a certain sense, if the bread is sliced in two different ways then there are two different loafs of bread. In another sense, the loaf of

bread remains identical throughout its various determinations. It is still a loaf of bread; it is only sliced differently. So, although the material substrate changes as its different determinations change, the material substrate also remains identical. The same holds for cats. The category "cat" remains identical **in** all the various kinds of cats. In this case, the material substrate may change -- just take a look at all the different types of cats -- but the category "cat" remains identical throughout its differences. By the same token, climate has changed drastically through billions of years. But the basic processes that bring about different climates and weather patterns have remained identical. Glacial periods, snowball earth, extreme greenhouse warming, current greenhouse warming, all the different determinations of climate are determinations of processes that have remained unchanged (identical) for billions of years.

In the essentialities or determinations of reflection, Hegel is examining not so much the identity and differences among things as the very concepts of identity and difference. Hegel is asking basic questions. What does it mean for two things to be identical? What does it mean for two things to be different? And what is the relation between identity and difference? The ways in which he answers these questions might lead one to accept Feuerbach's criticism that Hegel's dialectical is "thought playing a game with itself." Nevertheless, this chapter has important implications for "grounding" Hegel's *Logic*. I would characterize this chapter as somewhere between providing astoundingly important insight and merely containing some neat dialectical tricks. The relation between identity and difference is developed through the categories of diversity, opposition, and contradiction. I'll start with opposition and contradiction, and then come

back to diversity. We will again use the loaf of bread as our example. Here again is Figure 2-1.

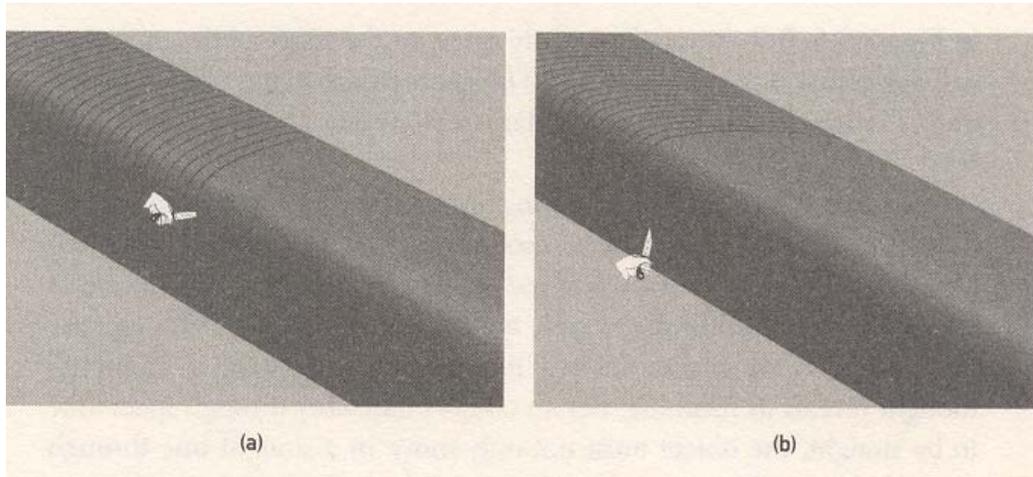


Figure 2-1. Sliced Bread.

(a) and (b) in Figure 2-1 cannot be compared unless they are both like and unlike each other; unless they are both identical and different (Hegel begins this point on p. 419). That (a) and (b) are like one another can be observed *only on the basis* that they are unlike each other. (a) is like (b) except that it is sliced in a different way. Conversely, that (a) and (b) are unlike one another can be observed *only on the basis* that they are like each other. (a) is unlike (b) because it is sliced differently than (b), and we can see this because both are sliced loafs of bread. Likeness can be observed only on the basis of unlikeness, and vice-versa.

Now, an obvious question arises if (a) and (b) are sliced the same way. Figure 2-4 puts (z), an unsliced loaf, in the place of both (a) and (b).

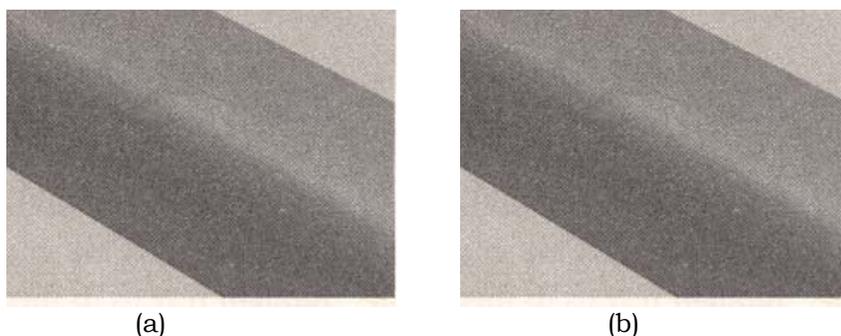


Figure 2-4. Unsliced bread.

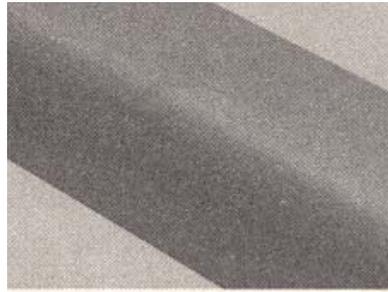
How does the claim that likeness can be observed only on the basis of unlikeness apply to (a) and (b) in Figure 2-4? Figure 2-4 represents what Hegel calls in "Remark 2" the "First Original Law of Thought": $A = A$. In truth, we do not even need (b) to express the principle of identity. Hegel's account of principle of identity, and the principle of non-identity, $A = \sim A$, is both sneaky and profound. First of all, in the formulation $A = A$, the first A is *not* the second A. There is *difference in their identity*. Although both are identical in that both are A's, they are different in that the first A is not the second A. Similarly, the likeness of (a) and (b) in Figure 2-4 can be observed only because (a) *is not* (b). (a) is different from or unlike (b) because it is not (b), and this is what allows us to observe the identity or likeness of (a) and (b). What allows us to observe their unlikeness, that (a) is not (b), is their likeness -- the very fact that each is an unsliced loaf of bread. As for $A = \sim A$, *not-A* is different from A, to be sure, but *not-A* is still an A. So *not-A* is identical with A.

The next obvious objection to the claim that unlikeness can be observed only on the basis of likeness is the following. What if, the objection goes, two things are so unlike each other (so different) that they are not alike (identical) at all. Figure 2-5

represents this objection. My cat and a loaf of bread are certainly different, but how are they identical?



(a)



(b)

Figure 2-5. My cat and a loaf of bread.

Hegel's response is again sneaky and profound. My cat and a loaf of bread are "at once alike and unlike; alike, simply because they are things, or just two, without further qualification -- for each is a thing and a one, no less than the other -- but they are unlike *ex hypothesi*" (423). My cat and a loaf of bread are alike insofar as each is one thing and not the other. And, on this basis, a quick glance at Figure 2-5 shows that they are also unlike.

"Comparison" of two objects, like two loaves of bread, or my cat and a loaf of bread, is an "external relation" because comparison depends upon the perspective of a third person, an observer, to point out likeness and unlikeness. "Opposition" and "Contradiction" are further developments of comparison; developments that do not

depend upon an observer, or external relations. In opposition and contradiction it is not objects that are under consideration but the very categories of likeness and unlikeness. We saw in comparison that likeness is not possible without unlikeness, and vice-versa. In opposition, likeness and unlikeness are "reflected-into-each other." Unlikeness is certainly the opposite of likeness. Unlikeness is not-likeness. And likeness is certainly the opposite of unlikeness. Likeness is not-unlikeness.

Here is where the reader has to decide whether the movement from opposition to contradiction is an important insight or a neat dialectical trick, or both. Opposition identifies that likeness is not-unlikeness and unlikeness is not-likeness. Likeness and unlikeness are different. Contradiction shows that likeness and unlikeness are exactly the same. Yes, you read that right: in contradiction likeness is identical with unlikeness.

The argument could be put in the following way.

unlikeness is not-likeness (opposition)
not-likeness is not-like itself (this follows from the very nature of not-likeness)
not-likeness is not not-likeness
not not-likeness is likeness
Therefore unlikeness is likeness (contradiction)

And:

unlikeness is not-likeness (opposition)
not-likeness is like itself
not-likeness is not-likeness
Therefore unlikeness is like itself
Therefore unlikeness is likeness
Or likeness is unlikeness (contradiction)

The claims that likeness is unlikeness, and unlikeness is likeness, are certainly contradictions. But that's the whole point. The difference between opposition and contradiction is that in contradiction the opposite is identical with that to which it is opposed. This is what Hegel means when he repeatedly claims that in essence "negation is equal to itself."

And so likeness is not like itself; and unlikeness, as unlike not itself but something else unlike it, is itself likeness. The like and the unlike are therefore *unlike themselves*. Consequently each is this reflection: likeness, that it is itself and unlikeness, and unlikeness, that it is itself and likeness (421).

We could substitute "identity" and "difference" for "likeness" and "unlikeness" in the argument above and arrive at the same result. The point is that in essence negation of negation contains moments of identity *and* moments of difference.

We noted that the only way to arrive at something positive is through negation of negation. Based on the argument above we can now see why:

positive is the opposite of negative
the opposite of something is its negation
positive is not-negative
Therefore the positive is the negation of negation

All positive existence is underwritten by negation of negation. Positive existence has a negative underbelly which you may not see, but it's there. Beneath the surface of positive existence lie all sorts of "negative" activity, be it in the realm of randomness and sub-microscopic weirdness of quantum mechanics; the vibrating strings in the superstring theory of physics; the unconscious in human beings; geological processes going on underneath the crust of the earth; or the DNA found in every single cell of every living organism, a genetic code that is responsible for all the phenotypes (bodily structures) that have ever existed. In Hegel-speak, the negative underbelly is responsible for the surface of positive existence insofar as the surface of positive existence is the negation of its negative underbelly (for the moment, we have to put the point in this odd way; things will change as "ground" develops). The relation between the surface of reflection and its negative underbelly is a further development of the relation between the material substrate and its various determinations.

It is now easy to understand the difference between "diversity" and "difference."

Hegel characterizes diversity this way:

The moments of difference...are [merely] diverse when they are reflected into themselves, that is, when they are *self-related*; as such, they are *I the determination of identity*, they are only relation-to-self; the identity is not related to difference, nor is the difference related to identity (418).

Diversity simply means that there is no unity, no identity, among different elements. Consider the greenhouse gases -- CO₂, CH₄, N₂O, O₃, chlorofluoro-carbons. These are a few of the many diverse gases in the atmosphere. What unifies them, giving them an element of identity, is that they reflect infrared radiation back down to the surface of the planet instead of allowing it to escape. Or, as another example, all the differences among materially existing cats have an element of unity inasmuch as they are instances of the category "cat." The contingent differences among cats, the differences that are not related to the category "cat," are mere diversity. For example, male lions have manes, some cats have no tails, cats have different markings, some hunt wildebeests while others hunt mice and birds, some meow while others roar, some are small while some are large.

In sum, "The Essentialities or Determinations of Reflection" contains three main points. (1) As part of essence, positive existence is negation of negation. (2) Identity always contains an element of difference. And (3) difference also contains an element of identity. These points are now further developed in "Ground"

Ground

Is identity the ground of difference? Or is difference the ground of identity?

Both. There can be no identity without difference, and no difference without identity. In

fact, identity automatically entails difference, and vice-versa. By the same token, there can be no loaf of bread without slicing it in some way (including (z)), and there can be no slices of bread without the material substrate of a loaf to slice. Capital cannot exist without being grounded by its various determinations and the various determinations, in turn, ground capital. Likewise, climate is the ground of weather, and weather grounds climate (remember that climate is the average of weather events). Each pole of essence grounds the other. This relation follows from the three forms of reflection, which culminate in the mutual determination of "determining reflection," and from the interplay of identity and difference.

Still, there is something wishy-washy about this constant movement from one pole to the other. As described in the opening paragraph of the previous section, one would expect that the ground to be that which remains identical throughout its differences, just as the category "cat" remains identical in different materially existing cats. In the same way, one would also expect that the material substrate of the loaf of bread is the ground of the different ways in which the bread can be sliced. The topic of this discussion is global *climate* change, not global weather change. One would expect climate to be the ground of changing weather patterns. For example, global warming induced climate change means increased and heavier precipitation events, more frequent droughts, and more frequent and intense heatwaves. Even though, as Hegel maintains, the negations are "equal," one would expect one pole of essence to take precedence over, and thereby ground, the other pole. Marx holds as much in the *Grundrisse*, where he writes that the material conditions of production are the true ground of capital as well as the ground of circulation. "While, originally, the act of social production appeared as the

positing of exchange values and this, in its later development, as circulation -- as completely developed reciprocal movement of exchange values -- now, circulation itself returns back into the activity which posits or produces exchange values [material-social production]. It returns into it as into its ground" (Marx, 1973, 259).

As in positing reflection, the grounded circles back upon the ground. But unlike positing reflection, there should be a clear distinction between ground and grounded, in which one pole of essence takes precedence over the other. For instance, a ground of climate change is emitting greenhouse gases into the atmosphere and the socio-economic conditions bound up with these emissions. The current and projected impacts of global warming, as well as global warming itself, are grounded by greenhouse gas emissions. In this case, there is a clear distinction and connection between ground and the grounded. Moreover, Figure 1-13, in addition to our quantitative analysis of climate change, shows how socio-economic conditions are grounded by climate change.

In the chapter on ground, Hegel combines all these features. One pole of essence takes precedence over the other, and yet the grounded, as in Figures 1-13, 2-2, and 2-3, circles back upon the ground. What is more, ground shifts from being a material substrate to being an *interaction* among material conditions. In other words, ground goes from being some sort of foundation that is carved up into various determinations to changing conditions that produce new effects (the grounded) as they enter into new relations. This transition occurs rather smoothly. We know that the material substrate is only found **in** its various determinations. And we know that the material substrate remains identical throughout its differences. The determinations of the material substrate simply become conditions that interact with each other, and the "fact" (or event, the

grounded) emerges from relations among these conditions. The grounded, what emerges from the conditions, is a continuation of the conditions and in this respect the ground is identical with the grounded. For example, the surface world we experience is the very same world that is comprised of the strangely behaving particles of quantum mechanics and, possibly, countless strings vibrating at different rhythms. The mostly tranquil surface of the earth we inhabit is a continuation of massive turmoil and upheaval going on underneath. Our conscious experience is, if Freud is right, a continuation of our unconscious drives and instincts. Phenotypes are the continuation of the DNA that is "coded" by them. At the same time, there is clearly a marked difference between the surface and its negative underbelly.

So we have already laid the ground for this transition in observing that the negative underbelly generates the surface of positive existence. From this standpoint, the negative underbelly is the changing conditions (the ground) and the surface of positive existence becomes the grounded. Now that we know the conclusion, we can work our way through the transition from ground being a material substrate to ground being an interaction among material conditions.

In the opening section of "Ground," Hegel writes: "Ground is first, *absolute ground*, in which essence is, in the first instance, a substrate for the ground relation; but it further determines itself as *form* and *matter* and gives itself a *content*" (445). We have seen how the material substrate and its determinations turn into essence. Recall, too, that positive existence is generated by negation of negation. Hegel follows through with this thought in a passage that is cryptic even by his standards. He is discussing the "proof" I gave above, with regard to likeness and unlikeness.

The self-identical negative and the self-identical positive is *now one and the same*

identity. For ground is the identity of the positive or even of positedness, too, with itself; the grounded is positedness *qua* positedness, but this its reflection into self is the identity of the ground. This simple identity is not itself ground, for ground is essence *posited* as the not-positing *over against positedness*. As the unity of this determinate identity (of the ground) and of the negative identity (of the grounded), it is *essence as such* as distinguished from its *mediation* (447).

Let's decode this passage. We can see from the "proof" above how the self-identical negative and the self-identical positive are one and the same identity. In the passage above, Hegel adds an additional qualification: "ground is essence *posited* as the not-positing *over against positedness*." Contrary to appearances, the point here is simple, though it takes some explaining. The negative activity beneath the surface generates positive existence insofar as the surface of positive existence is (at this point) merely the negation of its negative underbelly. The surface is "positedness" in Hegel's sense. The negative underbelly is "posited as the not-positing." Since the negative underbelly is the ground and the surface is the grounded it makes sense to say that the grounded is posited by the ground. It seems odd, however, to hold that the ground is posited by the grounded. Yet a negative underbelly would not be an underbelly *of* anything if it did not have a surface; and a surface would not be a surface *of* anything if it did not have a negative underbelly. *Qua* ground, then, the negative underbelly has to be "posited" because it has to stand in relation to its surface; it has to be posited by the surface. At the same time, though, a ground cannot be posited by what it grounds because it is the ground that generates the grounded. It would make no sense to hold that a phenotype generates its DNA; or that the surface world generates the random behavior of quarks and the specific vibrations of superstrings; or that the crust of the earth generates the geological processes going on underneath it. Hegel resolves this contradiction by claiming that ground is "posited as not posited," or "determined as undetermined." Since essence is the relation

between the surface and its negative underbelly, ground as essence is posited (the surface) as not-posited (the negative underbelly), or as independent, over against positedness (the surface).

In absolute ground the ground is still a material substrate. The loaf of bread is the material substrate of the different ways it can be sliced. Or the material substrate is the matter that the category "cat" carves up. We should again remind ourselves that the material substrate is only found **in** its various determinations. The determinations are the *form* of the material substrate. "Essence *has* form and determinations of the form." The determinations of the form, as we have seen, are the different ways the bread is sliced, different species of cats, and changing weather patterns. "It is only as ground," Hegel continues, "that it [essence] has a fixed immediacy or is a *substrate*" (448).

How form carves up the material substrate, how the surface is a reflection of its negative underbelly, is the completion of the three types of reflection in essence. "Form is therefore the completed whole of reflection...as well as being a unity of its determining, it is also just as much *related* to its sublatedness, *to an other* which is not itself form, but form is *in* it" (449). The "other which is not itself form" is indeterminate matter, such as the loaf of bread, and form is in the loaf as the way in which the bread is sliced: "form is the positing and determining principle; simple essence, on the other hand, is the indeterminate and *inactive* substrate in which the form-determinations subsist and are reflected into themselves" (449). The category "cat" is a "form-determination" or "determining principle" that determines the indeterminate substrate. "Cat" carves up indeterminate matter in a certain way just as slicing a loaf of bread carves up the material substrate of the bread in a certain way.

To better illustrate this, let's change our example from bread to cookies. Suppose you are baking cookies during Christmas. First you make the dough and spread it out on some wax paper. The dough is the indeterminate matter. Then you take your cookie-cutters and carve up the dough. You stamp the dough with forms of hearts, Christmas trees, stars, boxes (for presents), and so forth. The cookie cutters are forms that determine indeterminate matter. Now, cookies, by definition, take on some determinate form. We do not just slice the dough up and throw in the oven in any which way. So in Hegel's sense the form is **in** the dough. Without the indeterminate matter of the dough, the cookie-cutters, the form, would be useless. Just as cookie-cutters cry out for dough, form-determinations require matter.

Something curious has happened. You can make "cookies", if they can still be called that, without using cookie-cutters. If you want, you can make some dough and cook it in the oven any which way you like. Matter has temporarily gained ascendancy over form because form is useless without matter, although matter is not useless without form. Cookie-cutters are useless without dough, but you can still make "cookies" without cookie-cutters. "[E]ssence is the indeterminate for which form is an other. As such, it is not essence, which is in its own self-absolute reflection, but is *determined* as formless identity; it is *matter*" (450). Matter may have gained temporary ascendancy over form, but it should come as no surprise that in the end both are of equal importance. That's why I placed "cookies" in scare quotes when speaking of formless dough. If you want to make cookies, so defined, you will have to give the indeterminate dough a determinate form. There is no such thing as an unformed cookie. Thus "form presupposes matter"

and, conversely, "form is presupposed by matter" (451). Form and matter are on equal footing.

It should now come as no surprise that matter and form are the same thing. "[F]orm is simply material, subsistent form" (454). Matter is that out of which form is made. Just as there is no such thing, as an unformed cookie all matter takes on a determinate form. Try imagining anything that does not have a determinate form. Although you may not have made cookies, even if you throw your dough in the oven willy-nilly it will still take on a determinate form. The indissoluble unity of form and matter is "content."

We just learned that identity always contains an element of difference and difference always contains an element of identity. Content is the difference and identity of form and matter. We can still, in principle, separate out the form of a cookie from the dough out of which the form is made. Likewise, we can tease out the category "cat" from all materially existing cats. In this respect, form is different from matter. But form is identical with matter in that matter is that out of which form is made.

So the form of the cookie and its material substrate (the dough) are two different ways of looking at the same thing -- the cookie itself. Similarly, the negative underbelly and its surface are different sides of one and the same content. The random behavior of particles in quantum mechanics and the undetectable vibrating strings of superstring theory form the surface world with which we are so familiar. Geological processes taking place beneath the earth's crust form the surface on which we live. Unconscious drives and impulses form and inform our conscious experience. DNA forms the phenotype. In all these cases, the negative underbelly is that out of which the surface

emerges. Although their content is identical, in the sense that the surface is a continuation of the underbelly, we can still distinguish between the surface and its underbelly. Just as form and matter are reflected into each other, the surface is a reflection of its negative underbelly, and vice-versa. Hegel was hinting at this point in the cryptic passage above. It has now come to fruition.

The content of the ground is, therefore, the ground that has returned into its unity with itself; ground is at first the essence that in its positedness is self-identical; as different from and indifferent to its positedness it is indeterminate matter, but as content it is also formed identity and this form becomes ground relation because the determinations of its opposition are also posited as negated in the content [form and matter are opposed, and as such, as with likeness and unlikeness, they turn out to be the same thing]. Further, the content is determinate in its own self; not merely like matter as the indifferent in general but as formed matter, so that the determinations of form have a material indifferent subsistence (455-456)

Although our examples make it clear which side is the ground and which side is the grounded, let's say that one side could just as easily be the ground of the other. This is the wishy-washy conception of ground that I pointed out in the opening paragraph, in which the substrate and its various determinations are exactly the same thing: "the whole form itself is as self-identical, the substrate of the determinations which are the two sides of the ground and the grounded, and thus form and content are themselves one and the same identity" (457). And "a determinate content is considered from *two sides* in so far as it is posited first as *ground* and again as *grounded*...*there is nothing in the ground that is not in the grounded*, and *there is nothing in the grounded that is not in the ground* (457, original emphasis).

Hegel dubs this scenario "formal ground." Formal ground is an empty concept because it doesn't really explain anything at all. If you interpreted Figures 2-2 and 2-3 in terms of formal ground all you would come away with is the platitude that 'it takes money to make money.' Though true, this platitude does not explain anything. Hegel's

example is that "the ground of the movement of the planets is said to be the *attractive* force of the earth and sun on one another." But "when one asks what kind of force the attractive force is, the answer is that it is the force that makes the earth move around the sun; that is, it has precisely the same content of the phenomenon of which it is supposed to be the ground" (458). Take, as a further example, the perfectly legitimate question 'why have CO₂ concentrations in the atmosphere spiked during the last 2000 years (see Figures 1-3 through 1-5)? Such a spike could occur without being caused by humans. Carbon, however, has a specific half-life, which means that it decays at a mathematically determinable rate. Radiocarbon dating of artifacts and fossils is based on the half-life of carbon. Now, carbon in the atmosphere burned from fossil fuels is older than carbon in the atmosphere that is there as the result of more recent "natural" causes. This is because fossil fuels are formed out of organic matter hundreds of millions, even billions, of years old. So if we were to scoop out some carbon dioxide from the atmosphere we could tell which carbon dioxide is there as a result of burning fossil fuels and which carbon dioxide is there as a result of more recent "natural" causes. Based on carbon-dating, the evidence showed that the best explanation for the spike in CO₂ concentrations is human emissions. Leaving the explanation at that exemplifies Hegel's formal ground. CO₂ emissions are the ground and CO₂ concentrations are the grounded. Both are the same content, but one would expect the ground and the grounded to be a little more expansive than this explanation. We need to expand the ground to what is responsible for increased CO₂ emissions, and we need to expand the grounded to the impact increased CO₂ concentration has on...well...the ground.

"Real ground" does just this. But real ground expands too far. In real ground

ground and grounded have a distinctive content, the ground relation has ceased to be formal, the retreat into the ground and the emergence from it of the posited is no longer a tautology; the *ground* is realized. Therefore when we ask for a ground, we really demand that the content of the ground be a different determination from that of the phenomenon whose ground we are seeking (462).

Suppose we are studying the current impacts of climate change and we arrive at the data shown in Figure 2-6.

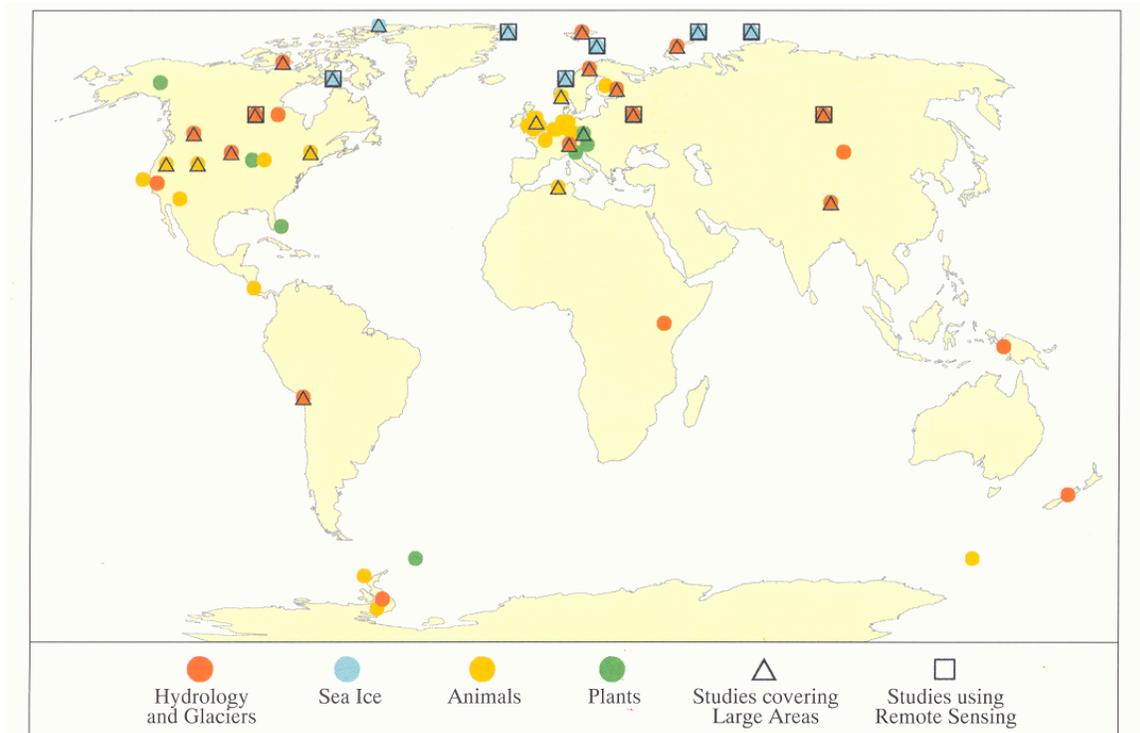


Figure 2-6. Locations at which systematic long-term studies meet stringent criteria documenting recent temperature-related regional climate change impacts on physical and biological systems. Hydrology, glacial retreat, and sea-ice data represent decadal to century trends. Terrestrial and marine ecosystem data represent trends of at least two decades. Remote-sensing studies cover large areas. Data are for single or multiple impacts that are consistent with known mechanisms of physical/biological system responses to observed regional temperature-related changes. For reported impacts spanning large areas, a representative location on the map was selected. (Text and graph reprinted from IPCC, 2001, 223).

The IPCC reports that "there is *high confidence* [67-95%] that recent regional changes in temperature have had discernible impacts on many physical and biological systems" (223). Among these impacts are "shrinkage of glaciers, thawing of permafrost, later freezing and earlier break-up of ice on rivers and lakes, lengthening of mid- to high-latitude growing seasons, poleward and altitudinal shifts of plant and animal ranges, declines of some plant and animal populations, and earlier flowering of trees, emergence of insects, and egg-laying birds" (222). See Figures 2-12 through 2-17 for more impacts. The evidence that the ground of the impacts is climate change is based on

stringent criteria [that] reduced the number of studies used in the analysis to 44 animal and plant studies that cover more than 600 species. Of these species, about 90% (more than 550) show changes in traits over time. Of these 550+ species, about 80% (more than 450) show change in a direction expected given scientific understanding of known mechanisms that relate temperature to each of the species traits. The probability that more than 450 species of 550+ would show changes in the directions expected by random chance is negligible (IPCC, 242).

The last sentence infers the ground from the grounded, as does the last sentence in the following paragraph.

Sixteen studies examining glaciers, sea ice, snow cover extent/snow melt, or ice on lakes or streams included more than 150+ sites, 67% (100+) show changes in traits over time. Of these 100+ sites, about 99% (99+) exhibited trends in a direction expected, given scientific understanding of known mechanisms that relate temperatures to physical processes that govern change in that trait. The probability that 99+ of 100+ sites would show changes in the directions expected by chance alone is negligible (IPCC, 242).

The ground of the changes observed in biological and physical systems is climate change. More recently, Parmesan and Yohe's "meta-analyses of 334 species and the global analyses of 1,570 species (or functional/biogeographic groups) show highly significant, nonrandom patterns of change in accord with observed climate warming in the twentieth century, indicating a very high confidence (>95%) in a global climate change fingerprint (Parmesan and Yohe, 2003, 41). (See also Walther *et al*, 2002; and Thomas *et al*, 2004)

Figure 2-7 is a more detailed account of this ground. For present purposes, pay attention to only the first two columns. The last three columns will be discussed below.

It is also helpful to compare Figure 2-7 with Figure 1-17.

<i>Sector</i>	<i>Historic emissions in 1990 (MtC_{eq}/yr)</i>	<i>Historic annual growth rate over 1990-1995 (%)</i>	<i>Potential emission reductions in 2010 (MtC_{eq}/yr)</i>	<i>Potential emission reductions in 2020 (MtC_{eq}/yr)</i>	<i>Net direct costs per tonne of carbon avoided</i>
Buildings ^a CO ₂ only	1,650	1.0	700–750	1,000–1,100	Most reductions are available at negative net direct costs.
Transport CO ₂ only	1,080	2.4	100–300	300–700	Most studies indicate net direct costs less than US\$25/tC but two suggest net direct costs will exceed US\$50/tC.
Industry CO ₂ only – Energy efficiency – Material efficiency	2,300	0.4	300–500 ~200	700–900 ~600	More than half available at net negative direct costs. Costs are uncertain.
Industry Non-CO ₂ gases	170		~100	~100	N ₂ O emissions reduction costs are US\$0–10/tC _{eq} .
Agriculture ^b CO ₂ only Non-CO ₂ gases	210 1,250–2,800	n.a.	150–300	350–750	Most reductions will cost between US\$0–100/tC _{eq} with limited opportunities for negative net direct cost options.
Waste ^b CH ₄ only	240	1.0	~200	~200	About 75% of the savings as methane recovery from landfills at net negative direct cost; 25% at a cost of US\$20/tC _{eq} .
Montreal Protocol replacement applications Non-CO ₂ gases	0	n.a.	~100	n.a.	About half of reductions due to difference in study baseline and SRES baseline values. Remaining half of the reductions available at net direct costs below \$200/tC _{eq} .
Energy supply and conversion ^c CO ₂ only	(1,620)	1.5	50–150	350–700	Limited net negative direct cost options exist; many options are available for less than US\$100/tC _{eq} .
Total	6,900–8,400^d		1,900–2,600^e	3,600–5,050^e	

^a Buildings include appliances, buildings, and the building shell.
^b The range for agriculture is mainly caused by large uncertainties about CH₄, N₂O, and soil-related emissions of CO₂. Waste is dominated by methane landfill and the other sectors could be estimated with more precision as they are dominated by fossil CO₂.
^c Included in sector values above. Reductions include electricity generation options only (fuel switching to gas/nuclear, CO₂ capture and storage, improved power station efficiencies, and renewables).
^d Total includes all sectors reviewed in WGIII TAR Chapter 3 for all six gases. It excludes non-energy related sources of CO₂ (cement production, 160 Mt C; gas flaring, 60 Mt C; and land-use change, 600–1,400 Mt C) and energy used for conversion of fuels in the end-use sector totals (630 Mt C). If petroleum refining and coke oven gas were added, global year 1990 CO₂ emissions of 7,100 Mt C would increase by 12%. Note that forestry emissions and their carbon sink mitigation options are not included.
^e The baseline SRES scenarios (for six gases included in the Kyoto Protocol) project a range of emissions of 11,500–14,000 Mt C_{eq} for the year 2010 and of 12,000–16,000 Mt C_{eq} for the year 2020. The emissions reduction estimates are most compatible with baseline emissions trends in the SRES B2 scenario. The potential reductions take into account regular turnover of capital stock. They are not limited to cost-effective options, but exclude options with costs above US\$100 t C_{eq} (except for Montreal Protocol gases) or options that will not be adopted through the use of generally accepted policies

Figure 2-7. Historic emissions and estimates of potential greenhouse gas emissions reductions in 2010 and 2020. (Reprinted from IPCC, 2001, 298).

Imagine that you inferred that the observed changes in physical and biological systems (the grounded) in Figure 2-6 and Parmesan and Yohe's data are due to CO₂ emissions from buildings, transport, industry, and agricultural emissions of non-CO₂ gases in Figure 2-7. Strictly speaking, you'd be right. Your inference would exemplify "real ground" in that the ground and the grounded each have a distinct content -- CO₂ emissions and changing physical and biological systems, respectively. In real ground there is, as Hegel puts it, a "togetherness" in the ground-relation. As a mere "togetherness," however, real ground is incomplete. The two distinct contents of ground and grounded have no clear connection. To complete the explanation and arrive at "complete ground" we need to plug "formal ground" into "real ground." Formal ground maintained that increased CO₂ emissions caused increased CO₂ concentrations in the atmosphere. When we plug formal ground back into real ground, complete ground is the result: increased greenhouse gas emissions → increased atmospheric concentrations of greenhouse gases → global warming (see Figure 1-7 for how this occurs) → climate change → changes in physical and biological systems. Complete ground is more expansive than formal ground, and it supplies the links missing in real ground.

Naturally, the next question is 'what grounds the first stage' and 'what is grounded by the last stage'? Hegel's response is that the last stage grounds the first stage and, what is the same thing, the first stage is grounded by the last stage. In other words, there can be no ground without something that is grounded -- just as there can be no origin without its subsequent development and no surface without an underbelly. As in the cryptic passage above, since there can be no ground without something that is grounded, the grounded grounds the ground. Hegel puts it thus:

in one something, the determination *B* is implicitly connected with determination *A*; therefore in the second something to which only the one determination *A* immediately belongs, *B* is also linked with *A*. In the second something, not only is this second determination a mediated one, but the fact that its immediate determination is ground is also mediated, namely, by its original connection with *B* in the first something. This connection is thus the ground of ground *A* and the *whole* ground-relation is, in the second something, a posited or a grounded (468-469).

Say determination *B* is observed changes in physical and biological systems, and determination *A* is significantly increased greenhouse gas emissions. That *B* is "immediately linked" with *A* means that *A* cannot occur without *B* also occurring. *A* automatically entails *B*, which means that *A* is the ground of *B*. Although *B* is the grounded it is also the ground of *A*. *B* grounds *A* because *A* would not be the ground of *B* if *A* did not automatically entail *B*, if *A* occurred without *B* also occurring. So observed changes in physical and biological systems *ground* the fact that such changes are *grounded by* increased GHG emissions. This is how, and why, the grounded circles back upon the ground. Increased GHG emissions would not be the ground of changes in physical and biological systems if no such changes took place, if *A* did not automatically entail *B*. It is in this sense that the grounded grounds the ground or that, as explained in the cryptic passage, the ground is "posited by" the grounded.

Condition

This dialectical maneuvering leads to a simpler and more important point. The progressive stages above are all conditions. Increased GHG emissions is a condition that leads to increased GHG concentrations, which is a condition that leads to climate change, which is a condition that leads to changes in biological and physical systems. In addition, the conditions that lead to increased GHG concentrations are socio-economic conditions. All these conditions must coalesce in order to be the ground of changes in biological and

physical systems. Coalescing conditions are what we have called the "negative underbelly" and what is grounded by these conditions is "the fact." Conditions are the various determinations of an underlying substrate or a negative underbelly. "Substrate," "underbelly," and "underlying," however, are no longer appropriate terms because they have all been brought to the surface in the form of interacting conditions. Such conditions are vibrating superstrings; particles behaving randomly; geological processes; how DNA "codes for" phenotypes, the errors that occur in reading this code (known as mutations), and how the phenotype interacts with conditions in its natural environment; and, according to Freud, all the people who ended up on his couch were there as a result of "constitutional factors" involving unconscious drives and impulses combined with the external circumstances of life. When these conditions coalesce in a certain way,

*When all the conditions of a fact [an event or occurrence] are present it enters into existence... The fact [event] emerges from the ground. It [the event] is not grounded or posited by it in such a manner that ground remains as a substrate; on the contrary, the positing is a movement of the ground outwards to itself and its simple vanishing. Through its *union* with the conditions, ground receives an external immediacy and the moment of being. But it receives this not as something external, nor through an external relation... Ground, therefore, does not remain behind as something distinct from the grounded, but the truth of the grounding is that in it ground is united with itself, so that its reflection into another is its reflection into self (478).*

The substrate is no more. The substrate has evolved into changing conditions from which facts or events emerge. Coalescing conditions are the ground and what we previously characterized as "the surface" are events or affairs that emerge from these conditions. We saw above how the event is a continuation of its conditions (identity) and, at the same time, remains separate from its conditions (difference). Because ground and grounded, conditions and the events generated by them, are "reflection-into-self" (the event is reflected in its conditions, the conditions are reflected in the event) Hegel claims that the event "is not only the *unconditioned* but also the *groundless*, and it emerges from

the ground only insofar as ground has '*fallen to the ground*' and ceased to be ground: it emerges from the groundless, that is, from its own essential negativity or pure form" (478). What Hegel means in claiming, on the one hand, that the event depends upon its conditions, and on other hand, that the event is unconditioned is that the event and its conditions are inseparable and nothing else affects or conditions them. The event emerges from its own essential negativity, the latter being the conditions of the event.

The time has come to throw away the material substrate of the loaf of bread, the twine, and the cookie dough because the ground is always shifting. As in the examples above, conditions are always changing and new sets of conditions are coalescing and producing new events. This is why Hegel writes that when "all the conditions of the fact are present, that is when the totality of the fact is posited as groundless immediate, this scattered multiplicity *inwardizes* [*erinnert*] itself in its own self" (477). And the "*inwardization* of the conditions is at first the falling to the ground [*das Zugrundegehen*]...and the becoming of the ground." The German word *erinnern* means "to make inner or inward." The conditions are "inwardized" because if the event did not emerge from them they would not be conditions of anything at all. These conditions are, as Hegel notes, a scattered multiplicity: like becoming, conditions are perpetually interacting with each other.

Now that we have arrived at an adequate ground relation we can apply this relation to climate change. The primary conditional ground of climate change is the *form* of socio-economic relations among human beings. This form is inseparable from its matter -- GHG emissions, atmospheric concentrations, global-warming induced climate change, and impacts on human beings and other species. Again, the suffering and death

of humans and other animals, species extinctions, and degenerating physical systems are part of the form of socio-economic relations among human beings. The grounded literally returns to the ground in the form of impacts. It stands to reason that changing the form of socio-economic relations will change the conditions that bring about climate change, and thus change the economic, biological, and physical impacts of climate change. The final three columns in Figure 2-7 list more of the many steps that can be taken to mitigate climate change as well the estimated cost of these steps. Ultimately, mitigation must be accomplished on the "micro" level. Yet reducing greenhouse gases on the micro-level ultimately requires guiding principles from the macro-level. These are the policy options we explored in the quantitative analysis of climate change.

Existence

The policy options for mitigating climate are of course the ground of climate change. The ground of climate of change is, again, a coalescence of socio-economic, atmospheric, and climatic conditions. A ground, for Hegel, is not an unchangeable foundation. These conditions are malleable. As the ground shifts so does the grounded, the latter being the impacts of climate change. In other words, when certain conditions are present the impacts of climate change described above come into existence. Quite simply, if the conditions are not present, if climate change is prevented or mitigated, the impacts will not come into existence.

As Hegel formulates it, though for rhetorical purposes, "whatever exists has a ground and is conditioned." Nearly 500 pages into the *Science of Logic* we have arrived at the raw fact of existence. Soon we will be treated to a "thing" that exists. The point

for now is that whatever exists is dependent upon its conditions for existence. If you throw an acorn into the ocean it will not sprout into an oak tree; nor will an oak tree come to exist if an acorn is buried in sand or wedged in rocky terrain. The existence of an oak tree depends upon its ground, both literally and in Hegel's sense; the ground is conditions such as nutrients in the soil, access to sunlight, a proper amount of moisture, and room for its roots to expand, so forth. When all the conditions are present an oak tree will come to exist.

The coalescence of conditions, on which existence depends, are a far cry from the substrate discussed at length above.

Mediation through ground sublates itself, but does not leave the ground behind as substrate; in that case, what proceeded from the ground would be something posited, having its essence elsewhere, namely in the ground; but on the contrary, this ground, *as an abyss* [my emphasis], is the vanished mediation [the conditions vanish into what they bring into existence]; and conversely, it is only the vanished mediation that is at the same time ground...(483).

Ground is "an abyss" or "vanished mediation" in that the conditions that ground existence are continued in the grounded. What you see is what exists; what you do not see are all the conditions that bring about what exists. For instance, the *observed* biological and physical impacts of climate change discussed above are the outgrowth of socio-economic, atmospheric, and climatic conditions that are not immediately within the purview of the observed changes in physical and biological systems. Look out your window and you see earth's crust; you do not see the geological processes going on below. Look in the mirror and you will see a phenotype; you do not see the genetic code that gives you your physical features. Look through today's most powerful microscope and you still will not see the tiny strings postulated by superstring theory. "Now because Existence is essentially mediation-with-self, the *determinations* of the mediation [the

conditions] *are present in it* [Existence], but in such a manner that they [the conditions and existence] are also reflected into themselves" (483).

Existence can be thought of as a fixation of the flux of ever changing conditions; as a particular moment, or freeze-frame, in the perpetual process of becoming. Any particular fixation of the flux of conditions is "the thing" or an "existent." What exists is a result of coalescing conditions. But since these conditions are not always discernible, some have taken existence as the surface phenomenon of the "thing-in-itself." As with the essential and the inessential, the thing-in-itself is supposed to be the "real thing" while what we see is only the phenomenon, or the surface, of a much deeper, truer reality. In this section, Hegel is grinding some philosophical axes, and the discussion requires quite a bit of background. I will briefly summarize it in order to move on to appearance.

The thing-in-itself is supposed to ground external existence, but it does not take on any of the properties of Existence. For example, when I describe something as red, with a velvet-like texture, having a green stem, fragrant, and thorny, I am describing the properties of a rose but I am not describing the rose in itself. Properties of the rose-in-itself are supposed to fall "outside the thing-in-itself" (485). The problem with this view is that apart from its properties the thing-in-itself is nothing at all. All you can say about the thing-in-itself is that it is not any property and that it is not the surface phenomena we experience everyday. Yet what distinguishes one thing from another is the properties of that thing. Take another look at Figure 2-5. My cat is distinguished from a loaf of bread because my cat is furry, has ears, eyes, organs, legs, stripes, and sleeps all day, while a loaf of bread is grainy, immobile, made of simple ingredients like yeast, is brown, shaped like a rectangle, etc. "[T]he thing therefore contains the difference of itself from other

things solely in its property...The true in-itself is the in-itself in its positedness: and this is its property. With this, *thinghood has passed over into property*" (491).

In describing the properties of my cat and a loaf of bread we were really describing certain features of matter. Just as form is inseparable from matter, properties too are made out of matter. The markings on my cat are comprised of the texture of countless hairs and the color of bread is bound up with its physical composition. Hegel is relatively straightforward on this point. "The transition of property into matter or into a self-subsistent *stuff* is the familiar transition performed on sensible matter by chemistry when it seeks to represent the properties of color, smell, taste, and so on..." (492). If you want to understand properties you must understand the stuff, the physical composition, which give properties a determinate form. Wood, metal, and wool all have different properties because they have different physical compositions. They are all made of different "stuff." Since properties depend upon physical composition, it is physical composition that makes this thing, for instance, a cat, and this other thing, a loaf of bread, two distinctive things. Physical composition individuates things; it is what makes a thing this particular, determinate thing.

Hegel goes on to discuss the idea that "particular matters" "*pass out of and beyond this* thing, continue themselves into other things, and the fact that they belong to this thing is not a limitation for them" (494). Particular matters out of which properties are comprised are indifferent to the things in which they find themselves. This leads to the "Dissolution of the Thing" and the idea, popular in Hegel's time, of the porosity of matters. The important point to bear in mind is that existing things relate to each other according to their respective properties; properties are a matter of physical composition;

so things relate to each other according to their different physical compositions. We saw as much with quality and in Figure 1-11, reprinted below. Greenhouse gases contribute to warming in different ways because of their different properties, that is, their different physical composition.

Greenhouse gas	Atmospheric lifetime (years) ^a	Relative instantaneous contribution to warming ^b	Relative total contribution to warming ^b
CO ₂	50–200 ^c	53.2%	80.3%
Methane	10	17.3%	2.2%
CFCs	65, 130 ^c	21.4%	8.8%
Nitrous oxides	150	8.1%	8.7%

Figure 1-11. CO₂, CH₄, N₂O, and CFCs (chlorofluorocarbons) contribute differently to global warming because of their qualities. (Reprinted from van Kooten, 2004, 5)

Appearance

Hegel writes that "Existence as *essential* Existence is Appearance." In the essence-relation there are still two sides at work. The dichotomy of a surface and its negative underbelly has given way to Appearance and the conditions generating Appearance. Clearly, the latter dichotomy retains elements of the former dichotomy. So when we claim that things relate to each other according to their respective physical compositions or, more precisely, that things have their ground and conditions in other things, there is a definite sense in which these relations constitute a negative underbelly. In appearance, the emphasis falls not on things and their properties, but on how things relate to one another. Just as "the thing" is a fixation of the flux of shifting conditions,

the relations among things are also a fixation of the flux of shifting conditions. The regularity of these relations is a law. Consider, once again, Figure 1-2.

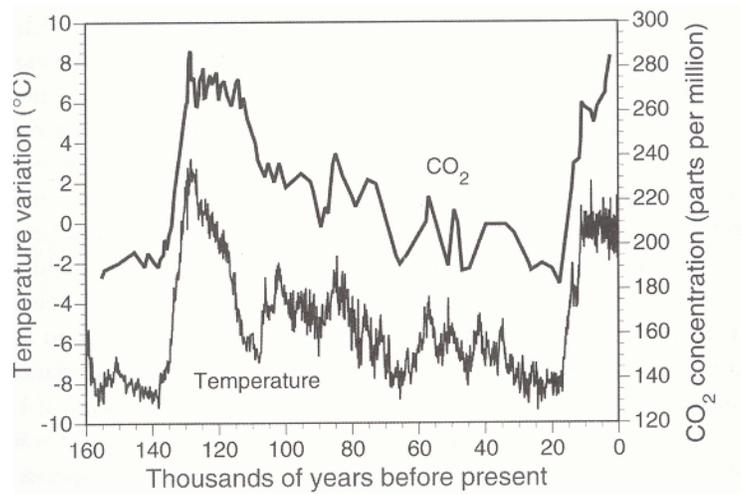


Figure 1-2. Atmospheric carbon dioxide (upper curve) and temperature variation (lower curve) over the past 160,000 years, from ice cores taken at Vostok Antarctica. (Graph and text reprinted from Wolfson and Schneider, 2002, 15).

Every time the CO₂ level has risen there has been a commensurate increase in surface temperature. This "law" has remained constant throughout fluctuating CO₂ concentrations over the past 160,000 years and is an expression, or Appearance, of the changing conditions that lead to fluctuations in CO₂ concentrations in the atmosphere. So "what remains self-equal in the flux of Appearance...is the *law of Appearance*" (500). Again, things have their grounds and conditions in other things and, very broadly, law is the regularity of what occurs when certain things enter into relations with other things under certain conditions.

Ordinarily, we may think of a law as something over and above, or separate from, things and their grounds and conditions. For example, all the complicated equations of

physics and the statistics used in evolutionary biology can seem to be removed from what they are equations and statistics *of*. We can work out all sorts of things on paper and, since the results come out so neatly, we assume that we are dealing with natural laws. Law seems to be "the *substrate* of Appearance" because it underwrites the regularity and stability of Appearance -- the equations yield consistent results. But "law is not beyond Appearance but is immediately *present in* it; the realm of laws is the *stable* image of the world of Existence or Appearance" (503, my emphasis). If a law is the ground, then this ground has to be grounded in empirical phenomena, or potentially be so grounded. A law cannot exist only "on paper" or in the mind.

Perhaps the best example of this is Einstein's theory of general relativity. Einstein put the finishing touches on general relativity in 1915, and then he applied his new equations for gravity to a variety of problems. One of these problems was that no equations had accounted for "the observed fact that Mercury does not trace the same path each time it orbits around the sun: instead, each successive orbit shifts slightly relative to the previous. When Einstein redid the standard orbital calculations with his new equations, he derived the observed perihelion [as it's called] precession precisely, a result he found so thrilling that it gave him heart palpitations" (Greene, 2004, 273). The next application of general relativity was the one that made Einstein famous. It shows that "law," in this case the equations of general relativity, "is not beyond Appearance but is immediately present *in* it."

Einstein also applied general relativity to the question of how sharply the path of light emitted by a distant star would be bent by spacetime's curvature as it passes by the sun on its way to the earth. In 1919, two teams of astronomers -- one camped out on the island of Principe off the west coast of Africa, the other in Brazil -- tested this prediction during a solar eclipse by comparing the observations of starlight that just grazed the sun's surface (these are the light rays most affected by the sun's presence, and only during an eclipse are they visible) with photo graphs taken when the earth's orbit had placed it

between these same stars and the sun, virtually eliminating the sun's gravitational impact on the starlight's trajectory. The comparison revealed a bending angle that, once again, confirmed Einstein's calculations. When the press caught wind of the result, Einstein became a world-renowned celebrity overnight (Greene, 2004, 273-274).

A law not immediately present in Appearance, in empirical phenomena, is no law. If the surface temperature of Earth was not roughly commensurate with CO₂ concentrations over the past 160,000 years there could be no law that surface temperature is roughly commensurate with CO₂ concentrations. By the same token, if there were no law that surface temperature is roughly commensurate with CO₂ concentrations, Figure 1-2 would look quite differently. The point is that the "realm of laws is the *stable* content of Appearance; Appearance is the same content [as the realm of laws] but presenting itself in restless flux" (504). This passage again emphasizes that the realm of laws is the regularity or stability of the constant movement of becoming. Law is a more highly evolved dialectical descendent of "determinate being," which is also a stable result of becoming (see pp. 16-20).

There is a certain difficulty in the relation between the realm of laws and Appearance that Hegel tries to solve in the final section of Appearance. This difficulty is also one of the main challenges in assessing climate change. The difficulty is that, ideally, a law should be general enough to explain *all* events falling under it and specific enough to explain a *singular* event. Formulating such laws is no mean feat. For example, Einstein's theory of general relativity explains the physical properties of the universe on a grand scale. So far, general relativity seems to be right: "No deviations from the predictions of general relativity have been found in experiments performed with our present level of technology" (Greene, 1999, 83). General relativity, however, cannot explain many events at the subatomic level, at which randomness reigns and Heisenberg's

uncertainty principle is the guiding light. On the one hand, then, the "usual realm of general relativity is that of large astronomical distance scales" (Greene, 1999, 127), but general relativity cannot account for the movement of particles on much smaller scales. Quantum mechanics is required at the subatomic level. On the other hand, the turbulent and jittery world of quantum mechanics does not account for the regular and stable world we experience every day, explained so well by general relativity. Quantum mechanics weirdly states that it is possible for you to walk through a wall provided that, at a subatomic level, all the particles in your body randomly arrange themselves so that they are not rebuffed by the random arrangement of the particles of the wall. It would probably take you longer than the age of the universe (14 billion years) to walk through a wall, but if the conditions are right, it is possible. The clash between quantum mechanics and general relativity arises when

under certain conditions...where things are very massive and very small -- near the central point of black holes or the whole universe at the moment of the big bang, to name two examples -- we require both general relativity and quantum mechanics for proper understanding. But like the mixing of fire and gunpowder, when we try to combine quantum mechanics and general relativity, their union brings a violent catastrophe. Well-formulated physical problems elicit nonsensical answers when the equations of both these theories are combined (1999, 118, my emphasis).

The clash between general relativity and quantum mechanics exemplifies the difficulty Hegel spells out in *Appearance*. General relativity is too general; quantum mechanics is, in its uniquely weird way, too specific.

In physics, superstring theory and M-theory have been developed to resolve this dilemma. Natural selection seems to resolve Hegel's difficulty altogether. In the *Origin of Species*, Darwin argues that natural selection is a better explanation for the development and observed variations in species than the then dominant explanation that species were created by God and are immutable (they do not change over time). The

manner in which Darwin frames his argument replicates Hegel's notion that things have their grounds and conditions in other things. Darwin writes:

...considering the infinite complexity of the relations of all organic beings to each other and to their conditions of existence, causing an infinite diversity in structure, constitution, and habits to be advantageous to them, I think it would be a most extraordinary fact if no variation ever had occurred useful to each being's own welfare, in the same way as so many variations have occurred useful to man (Darwin, 1859, 127).

And:

Owing to this struggle for life, any variation, however slight and from whatever cause proceeding, if it may be in any degree profitable to an individual and any species, in its infinitely complex relation to other organic beings and to external nature, will tend to be the preservation of that individual, and will generally be inherited by its offspring (61).

Though not always the case (1859, 303), Darwin emphasizes that variation is a slow, gradual process: "natural selection will always act with extreme slowness" (106). And the "laws" of natural selection operate at a mathematically determinable rate (see Ridley, 1996, 89-255). So natural selection is general enough to explain the development of all life on the planet. And it is specific enough to contribute to the explanation of things such as why certain animals have certain traits or why a particular species went extinct.

The science of climate change must also tread carefully between generality and specificity. As we saw in "Determination, Constitution, and Limit with regard to the European heatwave in 2003," "it is very likely (confidence level greater than 90%) that human influence has at least doubled the risk of a heatwave exceeding this threshold magnitude" (Stott *et al*, 2004, 610). What if we posed the following questions: is this particular weather event a result of global warming? Did global warming create *the conditions* such that the summer of 2003 was the hottest in Europe since at least AD 1500? It is not that it is impossible to answer these questions. The questions themselves are wrongheaded. As noted above, "it is an ill-posed question whether the 2003 heatwave was caused, in a simple deterministic sense, by a modification of the external

influence on climate -- for example, increasing concentrations of greenhouse gases in the atmosphere -- because any such weather event might have occurred in an unmodified climate" (610). We can lay out with a high degree of probability the general nature of the singular events that will emerge from conditions created by global warming -- more frequent and intense heatwaves, more precipitation, coastal flooding, increased storm surges, spread of tropical diseases, shortage of drinking water, heat related mortality and morbidity -- but it is impossible to claim that any single event "was caused, in simple deterministic sense" by the conditions set by global warming.

At least for the time being. For any single event to be caused, in a deterministic sense of automatically following from its conditions, the event has to be related to other singular events in a discernible pattern. Singular events have to take on a stable pattern in order to claim and any single event emerged from a coalescence of conditions. The stable pattern of events emerging from determinate conditions is Hegel's "law of appearance."

Such a pattern can be discerned in the increase in average temperature over the last decade and a half. According to the National Climatic Data Center, "data collected from weather and climate stations, satellites, ships, buoys and floats indicate that the 2003 average global temperature ranked as the second warmest year on record, tied with 2002 but cooler than the record warm year of 1998." As already noted, "the 10 warmest years have all occurred since 1990" (www.ncdc.noaa.gov). The NCDC also reports that "during the past century global surface temperatures have increased at a rate near 1.0 degrees F (.6 degrees C), but the trend has been three times as large since 1976, with some of the largest temperature increases occurring in the high latitudes." 2001 is the

fourth hottest year on record, and 1997 the fifth. Figures 2-8 and 2-9 illustrate this pattern.

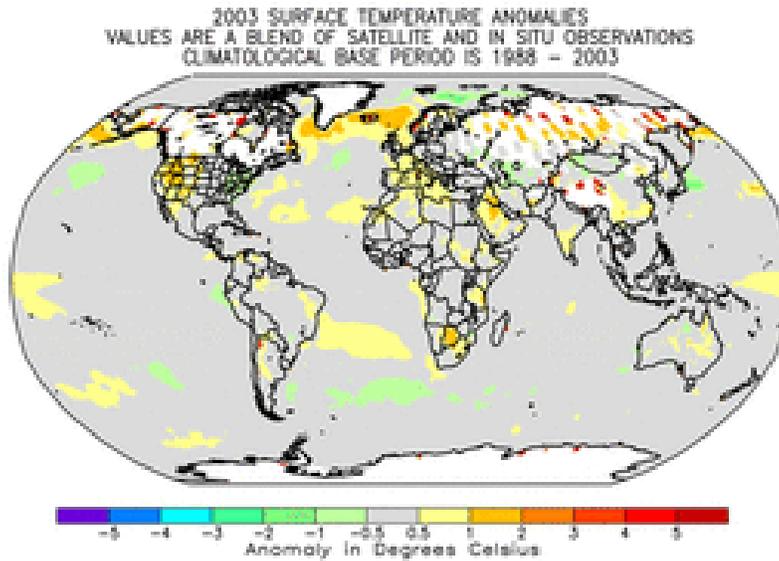


Figure 2-8. (Reprinted from *www.ncdc.noaa.gov*)

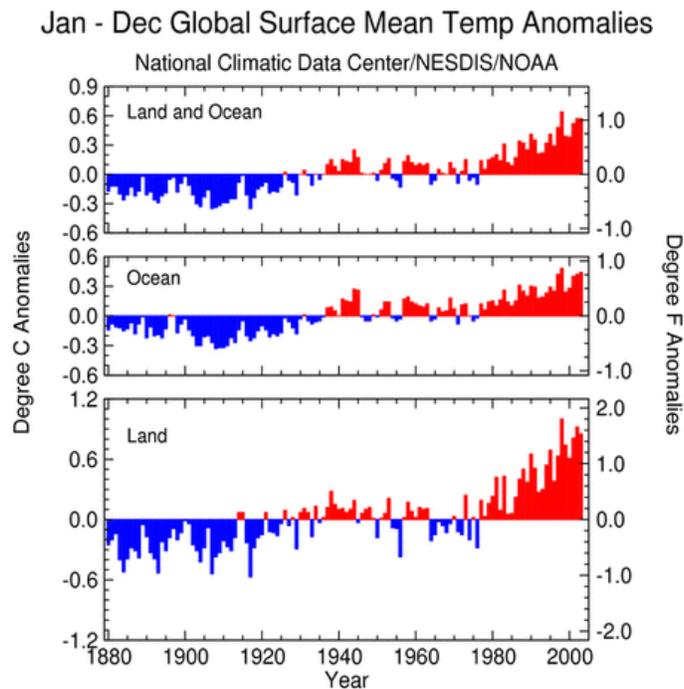


Figure 2-9. (Reprinted from *www.ncdc.noaa.gov*)

Clearly, the average global temperature of 2003, tied for second as the hottest year on record, makes sense only in relation to the previous years. Similarly, Hegel's point is that singular events make sense only in relation to other singular events and the conditions from which these events emerge. In this way, a string of events -- the annual temperature increase since 1976 -- forms a stable pattern. The "law of appearance," then, is inseparable from its conditions and events. A law is not something essential governing unessential events from afar. Rather, a law is **in** its events and conditions as they form a stable pattern.

Now, I claimed above that 'we can lay out with a great degree of probability the general nature of the singular events that will emerge from conditions created by global warming ...but it is impossible to claim that *any single event* "was caused, in simple deterministic sense" by the conditions set by global warming.' I followed this claim with the phrase 'at least for the time being.' In the next century if there is, for example, a shutdown of the Thermohaline Circulation System (THC) one could legitimately claim that this event "was caused, in a simple deterministic sense" by global warming or, less directly, by socio-economic relations among human beings. Past and current evidence demonstrates that natural laws dictate that the THC will shut down under certain conditions. Should northern Europe, large parts of Canada, and the northeastern United States become covered by glaciers in the next century or two this event will have been brought about by physical laws. The patterns of these laws and the conditions in which they operate have already been established.

Hegel expresses the unity of the law and various singular events this way. "Thus the world of Appearance [various singular events] and the essential world [of laws

governing these events] are each in themselves the totality of self-identical reflection and reflection-into-an-other...Both are self-subsistent wholes of Existence; the one [laws] is supposed to be only reflected Existence [the overall pattern of singular events], the other immediate Existence [the singular events themselves]; but each *continues* itself in its other and is therefore in its own self the identity of these two moments" (510). Natural laws are general patterns among singular events and singular events are expressions of natural law.

The Essential Relation

What does it mean for singular events to be "expressions of" natural laws? To say that events emerging from coalescing conditions are the *outer* expression of *inner* laws of nature seems tantamount to rehashing the notion that laws are separate from the phenomena of which they are laws. We seem to have regressed to the negative underbelly/surface scenario, in which natural laws underwrite what we see on the surface. We haven't exactly regressed to this scenario; rather, we have progressed from it. The inner laws of nature and their outer expression in singular events are a more highly evolved development of the surface and its underbelly. To see how, let's review, in reverse order, where we stand. Regular and predictable relations among things are tantamount to the "law of Appearance," or laws of nature. Things interact with each other according to their respective physical compositions. Things have their ground and conditions in other things. So the inner laws of nature govern how things interact with each other, according to their respective physical compositions, under certain conditions, and the results emerging from these interactions are what we have called "the surface." As before, the underbelly is **in** its surface.

"Essential Relation" is a further elaboration of how the inner laws of nature are **in** their outer expression. Essential relation is the relation of (a) whole and parts, (b) force and its expression, and (c) outer and inner. We have already discussed the relation between whole and parts in the feedback loop of infinity. The whole, the loop itself, is comprised of its various parts. In the same vein, "law" in Hegel's sense is a whole inseparable from its various events (its parts).

...the whole is equal to the parts and the parts to the whole. There is nothing in the whole which is not in the parts, and nothing in the parts which is not in the whole. The whole is not abstract unity, but unity as of a diverse manifold [diverse events]; but this unity, as that in which the elements of the manifold [the diverse events] are related to one another [my emphasis] is the determinateness of each element through which it is a part. (515)

As the saying goes, "the whole is greater than the sum of its parts." Sum is an appropriate word here, for, as with the difference between amount and degree in intensive and extensive quantum, the whole is not simply the parts bolted together in any way whatsoever. The whole is the unity of its parts. The whole is the relation between its parts. The emphasis falls not on the parts themselves but on the relation between the parts. As crude analogy, suppose **a** and **b** are parts of a whole. In the schematic representation of the whole **a** \leftrightarrow **b** the emphasis falls on the arrows more than **a** and **b** themselves because, as with quality, it is the arrows (the relation between the two) that give **a** and **b** their distinctive quality. Likewise, natural laws express the *relations between* things.

Figure 2-10 is a version of the feedback loop in Figure 1-13.

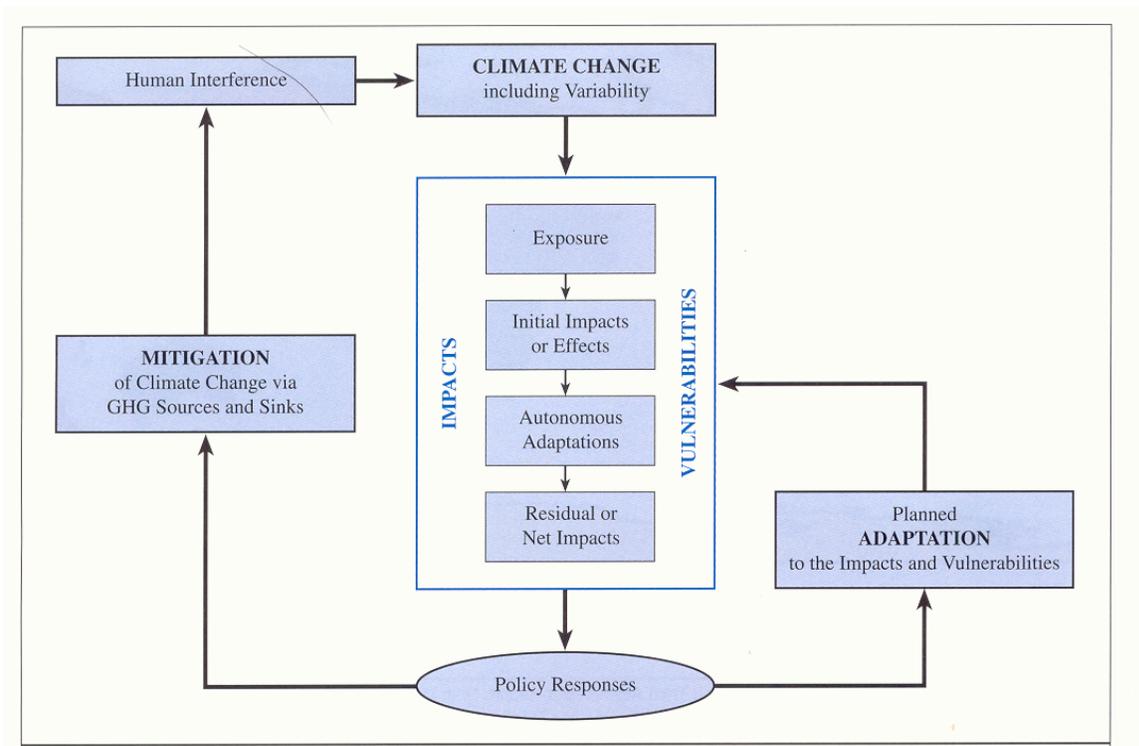


Figure 2-10. (Reprinted from IPCC, 2001, 239)

The whole may aptly be described as "the climate change problem." Figure 2-10 shows the unity among the parts of the whole. In this diagram, as well in climate change itself, it is the arrows, the relations between the parts, that holds the whole together.

Hegel states this in the following passage:

...although the whole is equal to the parts it is not equal *to them* as parts; the whole is reflected unity... The whole is not equal to them as this self-subsistent diversity, but to them *together*. But this their 'together' is nothing else but their unity (515, 516).

The arrows in Figure 2-10, roughly speaking, represent the "unity" or "togetherness" of the parts.

In "The Relation Between Force and Its Expression," the whole is further cemented when the relations between the parts become *suffused into the individual parts*. As with quality, the relations into which something enters comprise what that something is because things have their grounds and conditions in other things. In $a \leftrightarrow b$ the

emphasis falls on how the relations between the parts (the arrows) are internalized *in* the parts themselves. This should be evident in Figure 2-10 if you think of the arrows as penetrating the boxes "The manifoldness of its [the whole's] self-subsistent matter [the parts] is connected in a unity, but this unity [in the relation between whole and parts] is external to the matter. But the relation of *force* is the higher return-into-self in which the unity of the whole which constituted the relation of the self-subsistent otherness [of the parts], ceases to be external and indifferent to this manifoldness" (518). Following Figure 2-10, the unity that is external to the matter is when the arrows do not penetrate the boxes (of course, they always do, but Hegel is trying to describe a moment of dialectical development that will soon be overcome), force is how the arrows penetrate the boxes and the relations between the parts become infused into the individual parts. This is a crucial point: any individual arrow in Figure 2-10 gains its force from all the other arrows. It is in this way that the relation between all the parts (the whole) becomes internalized in any individual part. For instance, the arrow moving from "Human Interference" to "Climate Change" draws its force or momentum from the arrow coming from "Mitigation" (or lack thereof), this arrow draws its force from the arrow coming from "Policy Responses" (or lack thereof), and this arrow draws its force...and so to infinity in the Hegelian sense.

Force consists of two forces. As the interrelation of its parts, the whole becomes the active force. Think of this, again, as the movement and momentum of the arrows; while the parts, the self-subsistent matter, is passive force. Think of this as the arrows penetrating the boxes; suppose also that an arrow gains or loses force every time it passes through a box. The active force of the whole, the arrows, acts upon the passive force of

the parts, the individual boxes. "Passive force" seems like a contradiction in terms. Hegel's point is that the force acted upon actively "solicits" the acting force. This is, admittedly, a strange thought. But it makes sense. When there is an interplay between two or more things, all the sides must actively relate to each other in order for the interplay to take place, as in the rough schematic $\mathbf{a} \leftrightarrow \mathbf{b}$. Hegel phrases this point in a tongue-twister. One force "solicits only in so far as it is solicited to solicit. And so, conversely, the first force is solicited only in so far as it itself solicits the other to solicit it, namely, the first force." The force which is acted upon, say any box in Figure 2-10, is acted upon by another force, the arrows coming from another box, because it bears a particular affinity to the force that acts upon it. In this way, the passive force draws out the active force; in drawing out the active force the passive force is itself active. Look at the "Residual and Net Impacts" box and the "Policy Responses" in Figure 2-10. One might think of the impacts of climate change as being purely passive, for that is what the recipient of an "impact" is. But it is precisely such impacts -- namely, all the ones involved with moral principle (2) -- that should spur policy responses. Impacts, therefore, "draw out" or solicit policy responses. Now we can get better sense of Hegel's tongue-twister. Lack of policy responses means greater impacts, which means a greater need for policy responses. Thus "the first force [policy responses] is solicited only in so far as it itself solicits [through lack of policy responses] the other [impacts] to solicit it." In Hegelian argot, force relates to itself in an infinite self-relation.

In case your head is spinning, there is a simpler way to illustrate force and its expression. The collapse of 1,250 square miles of the West Antarctic Ice Sheet, shown in Figure 1-1, is an example of how force (global warming) expresses itself. The breakup of

the ice sheet is not a passive occurrence. It required the ice melting, melt ponds forming, and the ultimate collapse. Global Warming is an active force in that it sets in motion the forces it acts upon. In this way the forces that are set in motion "solicit" global warming or "draw out" the active force. In fact, the passive force drawing out the active force *is the same as* the active force setting the forces it acts upon in motion. Global warming would not be an active force were it not for its impacts, the forces it sets in motion; and the natural forces that are set in motion, shown in Figures 64-69 (as well as other impacts) would not be set in motion were it not for the active force of global warming.

This is just a more complex way of stating that global warming is inseparable from its empirical manifestations. As scientists predicted in the 1970s, the evidence of global warming should begin to manifest itself near the turn of the century. Had the empirical manifestations not occurred, had global warming as an active force not set other forces in motion, there would simply be no such thing as global warming. In sum, it is these manifestations that "solicit" global warming and, equally, global warming sets in motion such manifestations.

The forces set in motion by global warming are shown in Figures 2-11 through 2-16. These impacts belong in the "Vulnerabilities" boxes in Figure 2-10. How they fit into the whole can be divined by following the arrows. In addition to rising temperatures, global warming is only **found in** phenomena such as disappearing forests, flooding, droughts, rising sea levels, economic impacts, the extinction of species, and the suffering and death of humans and other animals. It seems a little odd to hold that all these things "solicit" global warming and that global warming is solicited in so far as it solicits its manifestations to solicit it. Yet this is the case. The main point is this: the *inner* laws of

nature that we see in action in Figures 2-11 through 2-16 are inseparable from their *outer* expression and everything is connected to everything else.



Figure 2-11. Glacial retreat in Denali National Park and Preserve, Alaska. (Reprinted from *National Geographic Magazine*, September 2004.)



Figure 2-12. The Everglades vast mangrove forests might not last much longer. A dramatic rise in sea level -- nine inches since 1930 in South Florida -- could put the mangroves under water this century. (Reprinted from *National Geographic Magazine*, September 2004).



Figure 2-13 (above). More droughts are occurring in some as a result of global warming. This picture is from Farson, WY. (Reprinted from *National Geographic Magazine*, September 2004)



Figure 2-14. Four million acres of Alaskan spruce stand dead, victims of the spruce bark beetle. The warmth has increased the number of mature beetles. (Reprinted from *National Geographic Magazine*, September 2004).



Figure 2-15. Mississippi River valley in Quincy, IL. It is very likely that more extreme precipitation events, and thus more flooding, will occur as a result of global warming. (Reprinted from *National Geographic Magazine*, September, 2004).

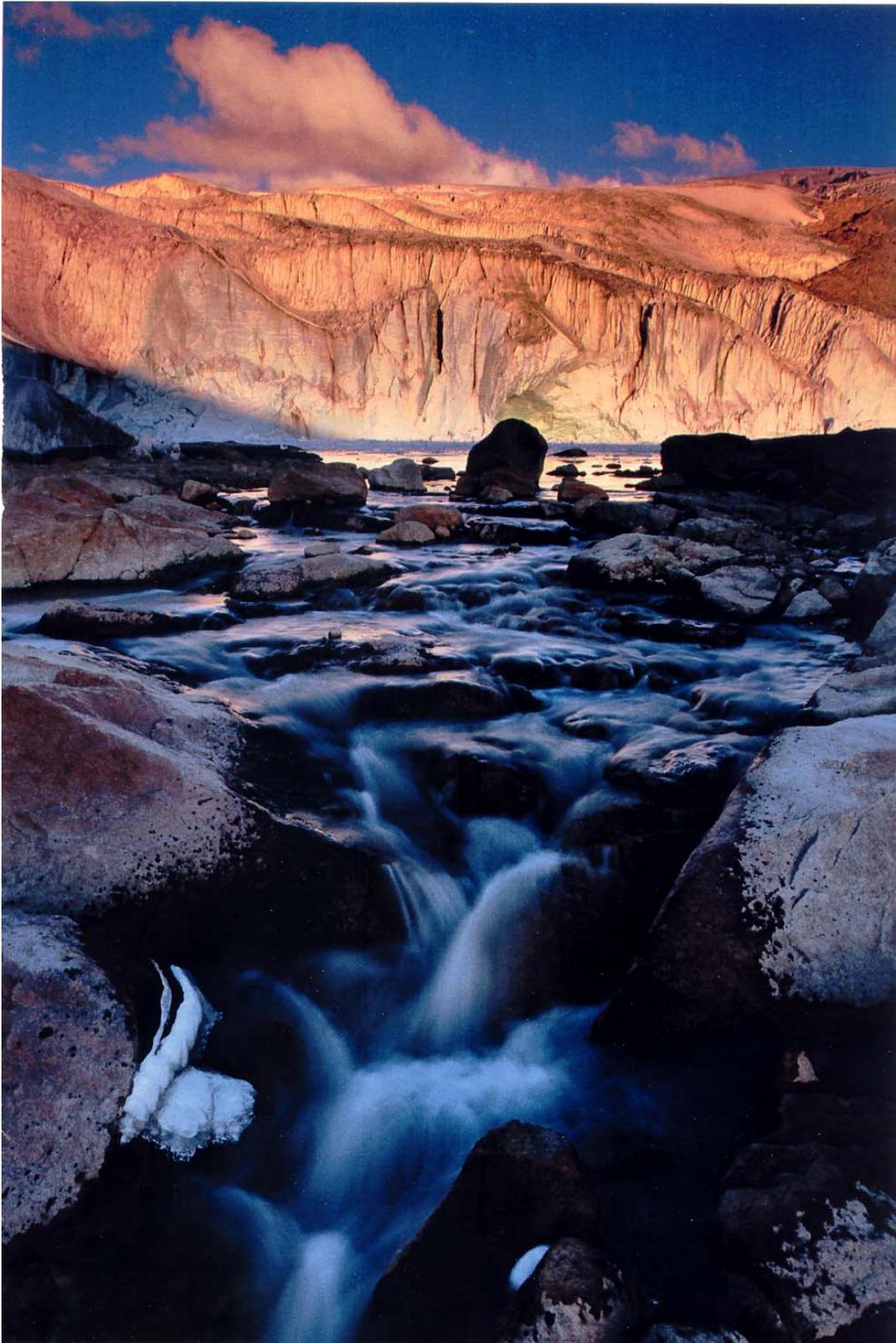


Figure 2-16. Peru's Quelccaya ice cap is the largest in the tropics. If it continues to melt at its current rate -- contracting more than 600 feet a year in some places -- it will be gone by 2100. Thousands rely on its water for drinking and electricity. (Reprinted from *National Geographic Magazine*, September 2004)

We should not lose sight of the fact that things have their grounds and conditions in other things. The events in Figures 2-11 through 2-16 have their grounds and conditions in global climate change. Global climate change has its grounds and conditions in global warming, which has its ground and condition through increased GHG concentrations in the atmosphere. The latter has its grounds and conditions in socio-economic relations among human beings. Events -- impacts, policy responses, adaptation -- emerge from the interplay of forces bound up with these conditions, depicted by the arrows in Figure 2-10. In other words, with the possible exception of socio-economic relations, climate change induced by global warming operates according to natural laws. These laws are inner laws, inner forces, that are one with their external manifestations or expressions.

We have arrived at "The Relation of Outer and Inner." Without inner laws there would be no outer manifestations. None of the events referred to in Figures 2-11 through 2-16 would take place if they were not governed by inner laws of nature. Conversely, there would be no inner laws if such laws had no outer manifestations, as pointed out above. Hegel frames the unity of inner laws and their outer manifestation in the following manner:

Outer and inner are determinateness posited in such wise that each of these two determinations not only presupposes the other and passes over into it as into its truth, but, in so far as it is this truth of the other, remains *posited as determinateness* and points to the totality of both. The *inner* is therefore the consummation of essence with respect to form. For essence, when it is determined as inner, implies that it is defective and is, only as relation to its other, the outer; but this, equally, is not merely being or even Existence, but relates itself to essence or the inner (526).

The inner is "the consummation of essence with respect to form" because the inner is "defective" without its outer manifestation. Form, in this case the form of inner natural laws, is always the form of *something*. As with our examples from the cookie and the

loaf of bread, form is nothing at all without being the form *of some determinate material*. Likewise, there is no such thing as a natural law that is not **found in** some real process.

Along these lines, Butler states that "[t]wo processes may be distinguished: the original movement into the manifestations, and the reverse movement out of the manifestations back into the inner force" (1996, 188). This raises an important point that has been ominously looming in the background. In claiming that inner laws are only **found in** their outer expression Hegel is not claiming that inner laws are *reducible to* their outer expression. An inner law is more than the sum total of its manifestations, at least because there are still unrealized (possible) manifestations of that law. Inner laws or forces are possibilities or dispositions that are known through "the reverse movement out of the manifestations back into the inner force." Inner laws that have been divined from their outer expression allow us to predict other possible manifestations of these laws. For instance, computer models used to predict the possible effects of global warming are based on what we know the climate has done in the past under certain conditions. The latter is, obviously, gathered from empirical evidence -- evidence that is the outer manifestation of inner laws. Given that conditions are always changing, "the original movement [of the inner law or force] into the manifestations" entails a certain possibility or probability. Under different conditions something else happens.

A perfect example of changing conditions is human interference with the climate system. When socio-economic conditions joined up with climatic conditions, the climate was altered. That is, different possibilities were realized because of changing conditions. Had human beings not altered climatic processes then other possibilities would have been realized because the conditions would have been different (see Figure 9 for an

indication). Inner laws may, to an extent, determine the conditions in which they operate, but inner laws are also *determined by* the conditions in which they operate. The inner laws set in motion by the rapid melting of Peru's Quelccaya ice cap were *determined by* other conditions, namely socio-economic conditions in industrialized countries coupled with atmospheric and climatic conditions. We will now explore this issue in more detail with "Actuality." Our guiding question will be: why does an inner force, or inner law of nature, manifest itself in one way and not another?

Actuality

In order to promptly address this question I am going to skip Chapter I of "Actuality." To answer the question 'why does an inner law of nature manifest itself in one way and not another' we first need to take a step back. We need to step back into the realm of sheer possibility, or formal possibility. On Hegel's view, actuality is always the actualization of possibilities. And, as Stephen Houlgate observes, "there is nothing in sheer possibility *as such* that guarantees that the possible will be actualized. The mere possibility that A might occur is thus -- as a mere *possibility* -- just as much the possibility that A might not occur" (1995, 39). The prospect that A might not occur is precisely what defines possibility. "For," Houlgate continues, "if there were no possibility that A might not be actualized, A would not just be possible but rather *necessary*" (39). If there were no possibility of *not-A* then A would be all there is, or can be. Hence A would be necessary. Hegel writes of sheer possibility that "[b]ecause, therefore, it is only a possible content, *another* and its opposite is equally possible. A is A; equally -A is -A" (544).

For instance, if you were to throw a piece of paper into the air over and over again, the possibility -- or probability, I equate the two for the moment -- of it landing on a particular side is 50%. But suppose, through some quirk of fate, that an inner law of nature dictated that the piece of paper must always land on side A. In that case, there is no such thing as possibility because *not-A* cannot be actualized. If an inner law of nature dictated that every time you throw the piece of paper in the air it must land on side A then landing on side A would be necessary. Landing on side A would be necessary because it could not be otherwise.

We know that, in reality, even if the piece paper landed on side A a thousand times in a row the probability that it will land on side A in your next toss is still 50%. In other words, A or *not-A* is a matter of contingency. Contingency means that matters could be otherwise. Therefore, on its most basic level, possibility takes the form of contingency: "there is in fact no such thing as *sheer* possibility in the abstract, but that all possibility takes the form of contingency, of some actuality that can just as well not be...certain things that *do* actually exist can just as easily *not* be what they are" (Houlgate, 1995, 41).

It is important to emphasize that because a possibility has not been actualized, that does not rule it out as an actual possibility. Actuality is not simply what is actual, or what has been actualized, as opposed to what is merely possible. Suppose you got lucky and after tossing the piece of paper in the air it landed on side A fifty times in a row. This does not mean that *not-A* is not an actual possibility. So to say that something is an actual possibility is to say that possibility is an actual feature of the world: "possibility is

now recognized to be an irreducible element of actuality itself. It, too, is what actuality is...possibility must form the very fabric of actuality itself" (40-41).

Let's sharpen this point. Borrowing another example from Greene, if "you tossed only two double-sided pages [in numerical order] in the air over and over again, you'd find that they landed in the correct order about 12.5 percent of the time. With three pages this would drop to about 2 percent of the tosses, with four pages it's about .3 percent, with five pages its about .03 percent, with six pages it's about .02 percent, with ten pages it's .000000027 percent...(Greene, 2004, 157). As the page numbers increase, the possibility that they will land in the correct order decreases. With ten pages, you would have to toss the pages in the air hundreds of thousands, perhaps millions, of times before they landed in the right order. Here we come to Houlgate's point. Suppose the 10 pages have never been in the right order; you could even number them without putting them in the right order. Just because the pages did not land in the right order after, say, five thousand tosses, does not mean that this possibility is not an actual feature of the world. A possibility does not have to be actualized for it to be an actual feature of the world. An actual possibility is not necessarily a possibility that has become actual.

Now we can get a better grip on how sheer possibility takes the form of contingency. Imagine that we unbind the 693 pages of *War and Peace* and shuffle them up. If the pages are out of order, a little calculation shows that there are
124552198853778343366002935370498829163361012463890451368876912646868689
559185298450437739406929474395079418933875187652765671405928662715136707
473912957138235380001610812646530182342056205714732061720293829029125021
317022782119134735826558815410713601431193221575341597338554284672986913

air and then gather them up in a neat stack (Greene, 2004, 152-153). Any possible arrangement that you do not throw is just as much a part of actuality as the arrangement that you do throw. It is of course entirely contingent what arrangement you come up with after tossing the pages and gathering them in a neat stack. In this sense, contingent events are groundless because they could have easily been otherwise. Yet contingent events also have a ground. The ground is nothing other than contingency itself. Contingent events "have a *ground* insofar as they are contingent *upon* one possibility or another being actualized" (Houlgate, 1995, 41). That it is entirely contingent which of 10^{1878} possible configurations of pages you will throw is what grounds the arrangement of pages you come up with after gathering them into a neat stack.

This is the first way in which contingency is necessary. The only thing that is necessary is contingency itself. If you threw the 693 pages of *War and Peace* into the air, gathered up the pages, and then claimed that the arrangement you threw was pre-ordained, you would simply be wrong. The only thing that was necessary was that the arrangement you threw could have been otherwise. Houlgate puts it thus: "the only thing necessitated by such necessity is the presence of contingency *as such*. Such necessity is not thought to govern what specific possibilities or contingent contents are actualized, because that is -- *necessarily* -- a matter of contingency" (1995, 42).

What, then, determines what possibilities or contingencies are actualized? This is another way of posing the questions with which we began. Asking why an inner law manifests itself in one way and not another is asking why A instead of *not-A*. Why are certain possibilities eliminated while other possibilities are actualized? If you toss the 693 pages of *War and Peace*, gather them up in a neat stack, then subtract 1 from the

number of possible arrangements given above, you can't help but ask yourself: why was this possibility realized instead of the roughly 10^{1078} others?

We already know the answer to these queries. One possibility is realized instead of all the others because the conditions and circumstances were such that this possibility could not not be realized. This is what Hegel calls real possibility. "Therefore what is really possible can no longer be otherwise; under the particular conditions and circumstances something else cannot follow" (549). When you toss the pages of *War and Peace* into the air "in principle, we could use the laws of classic physics to figure out exactly where each page will land after the whole stack has been thrown in the air" (Greene, 2004, 153). Although this task is well beyond the capacity of any supercomputer, it is conceivable that one could calculate the force with which you throw the pages, follow the precise motion of the 693 pages as they are caught in a gentle air current, jostle against one another, fall to the ground, and so forth. Using all these calculations, one could accurately explain why the pages landed in a certain order. Here, then, is the crucial point. Although it is contingent which arrangement you will come up with before you toss the 693 unbound pages of *War and Peace* into the air, every time you toss the pages into the air the laws of physics show that the arrangement you do toss *could not have been otherwise* given the conditions and circumstances (these being the force with which you toss the pages, how the pages slide and rub against each other, fall to the ground etc.). Prospectively, it's a crapshoot as to which arrangement you will toss; prospectively, the only thing that is necessary is contingency. Retrospectively, the arrangement that you did toss was *necessary* -- in Hegel's sense of "real necessity" -- given the conditions and circumstances in which you tossed the pages into the air.

Real possibility, therefore, becomes real necessity. "The real possibility of something is therefore the existing multiplicity of circumstances that are connected with it" (548); and "under particular conditions and circumstances something else cannot follow" (549). When we apply this to *all* conditions and circumstances we can see that the whole course of nature and history is necessary, in Hegel's sense of real necessity.

Houlgate puts it thus:

For, since all contingent circumstances and conditions are themselves rooted in prior conditions and give rise to subsequent conditions, it is clear that the whole course of contingency itself must be necessary. But, if the whole course of contingency is necessary, then there can be no real *contingency* in the world at all, since things could not be otherwise than they are.

Here, surely, we reach the real Hegel. He may claim that there is genuine contingency in the world, and he may even want to believe that there is; but, when one examines more closely what Hegel actually means by contingency, it becomes evident that, for him, whatever happens in nature or in history is in fact under the governing thumb of necessity.

What such a reading overlooks, however, is that the course of real necessity is itself *contingent* upon what there actually and contingently is. That is to say, specific "necessary occurrences" are contingent upon their antecedent conditions, and the whole course of real necessity is itself contingent upon what there actually is or happens to be as a whole. Indeed, the whole course of real necessity *is* simply what there actually and contingently is. Real necessity is thus not some independent power or force governing or determining what there is...there is no *independent* power of necessity in Hegel's universe which determines all that occurs (1995, 43-45).

It is important to note two points. First, necessity is contingent upon contingency, that is, contingency underwrites necessity. Houlgate phrases the point nicely: "'the course of real necessity is itself *contingent* upon what there actually and contingently is.'" To say that *x* necessarily follows from certain conditions is to say that *x* is contingent upon those conditions. Necessity and contingency are necessarily intertwined. Second, there is no independent power of necessity. Both entail what Hegel calls blind necessity.

Having said that, we can move on to absolute necessity. I emphasized above that conditions are always changing; they are always in flux. This means, quite simply,

that finite, contingent beings must cease to be. We saw as much in the section on finitude. Hegel said there, in effect, that everything is born to die. No finite, contingent beings, or finite, contingent conditions, can escape this fate. Hegel's notion of absolute necessity is, then, "blindingly simple: What must occur is what follows from the fact that there are and must be finite contingent beings in the world at all, namely that at some point those finite, contingent beings must *cease* to be. What is absolutely necessary in this world of contingency, therefore, is negation, destruction, death" (Houlgate, 1995, 46). The proper explanation is that destruction, negation, and death are absolutely necessary because that is what it means to be finite and contingent. This is the connection between blind necessity and absolute necessity. "What needs to be emphasized about Hegel's concept of absolute necessity is that the course laid down by such necessity converges completely with the course followed by the contingent things of the world -- *whatever* that may turn out to be. This is because absolute necessity determines nothing other than the fate *of* all contingent things, namely that they will end" (Houlgate, 1995, 47). When and in what manner finite, contingent things meet their fate is of course a matter of conditions and circumstances. The crux is that the "paths laid down by absolute necessity and contingency do not constitute two distinct sets of events in the world, but rather form *one* course of events"; absolute necessity and contingency "are one and the same process" (47).

Snowball Earth

Now that we have run the gamut from formal possibility to absolute necessity, I want to tie all these together in a single example. After doing so, I will complete the

argument that I began in the Introduction. The example is of global climate change, but it is from a little over 2 billion years ago and between 750 and 590 million years ago, respectively. I am speaking of Snowball Earth, which I mentioned in passing in the section on infinity in discussing feedback loops. Snowball Earth is a controversial hypothesis. As mentioned, Snowballs have happened twice. One occurred a little over 2 billion years ago and then a series of perhaps four engulfed the planet between 750 and 590 million years ago (Walker, 2003, 36). The biological evidence is questionable, but some have suggested that the final Snowball spawned multicellular organisms in what is known as the Cambrian Explosion. Our planet is 4.5 billion years old. The earliest fossil evidence for life is about 3.5 billion years old (Ridley, 1996, 544), and for over 3 billion years after that earth was covered in a primordial slime of bacterial mats and single celled organisms. The obvious question is why complex life appeared at all, and why it waited to appear until a few hundred million years ago? Clearly, the answer lies in the *contingent* conditions and circumstances from which complex life emerged. The fossil record for the emergence of complex life comes almost directly (in geological time) after the last Snowball. So there is at least a tangential connection. We'll discuss the biological aspect after examining how contingency and necessity melt together in the Snowball.

On Snowball Earth, the planet was covered in a sheet of ice that was, in some places, thousands of feet deep. The seas were frozen solid. Clouds disappeared. All precipitation came to a halt. Snowball earth was indeed a fluke contingent event. But, given the conditions, it was a real possibility. That makes Snowball earth, and all that

possibly resulted from it, a real necessity. Snowball earth, therefore, was both a random, chance event and a real necessity. Here's how.

We know that as tectonic plates shift they drag continents along with them. Continents "drift" at about the rate at which fingernails grow, though they may have been faster in the past. When India broke off from Antarctica and Africa it left Madagascar behind and, sixty million years ago, slammed into Asia. The result is the Himalayas, "the roof of the world." India is still pushing into Asia. The Himalayas grow by nearly half an inch a year. When a part of Africa that is now Italy, Greece, and the countries of the former Yugoslavia collided with Europe, the beginnings of the Alps were formed. When Spain slammed into France the Pyrenees were born (Walker, 2003, 242). The point, then, is that through shifting tectonic conditions the continents can crash together into one massive supercontinent.

When this condition obtains something else emerges. Rotating objects tend to balance themselves by keeping their weight distributed in their mid-section. Walker explains: "Suppose you drop a large lump of clay onto the top of a spinning basketball. If the lump was heavy enough, the basketball would tip over until the excess weight was spinning around its waist, and the system is safely back in balance" (2003, 240). The same principle applies to our rotating planet. When, through random continental drift, the continents bunch together into one supercontinent, this throws the planet off balance and the earth will try to shift the weight to the equator. The shift may work like this.

All the continents in the world don't weigh much compared to the Earth's massive innards: its thick mantle of plastic flowing rock and its hefty iron core. But...the supercontinent would act as an insulating cap over the mantle that lies beneath. Gradually the mantle would heat up, and a great plume of rock would rise up like lava beneath the supercontinent, lifting it up just like a giant pustule. Now, with continents and mantle together, the lump would tip the balance and the Earth would respond. Both supercontinent and underlying mantle would go flying off to the equator,

until the world became stable again (Walker, 2003, 240).

Let's keep track of these conditions; there are many more to come. First, there is random continental drift. This is the contingency, the sheer possibility, that gets it all going. Next the continents randomly drift into a massive supercontinent. This is followed by the tendency of rotating objects to stay in balance by shifting their weight to the center. The shift occurs when a supercontinent acts as an insulating cap and causes a great plume of rock to rise up beneath it. Then this mass skids to the equator. After that, "the hot plume of rock that still lay beneath the supercontinent would blast it apart in a frenzy of volcanic activity that left fragments scattered around the equator and tropics" (240).

Now, the tropics soak up most of the heat that arrives on earth from the Sun. Figure 1-51 shows how this heat is currently distributed through the "Great Ocean Conveyor Belt." But if the tropics are lined with the remnants of a supercontinent, if there is a great amount of land around the equator, conditions might be right for a Snowball to form. Land reflects heat more than oceans. So with land circling the tropics conditions will cool. Cooler conditions mean that the glaciers at both poles start expanding. Through the albedo effect, ice reflects sunlight, which means ever cooler conditions. As the glaciers expand through this feedback loop, there is no stopping them. Eventually, even the land at the tropics becomes covered in ice.

Normally, high latitude continents act as a buffer against advancing ice. For example, rocks help prevent the planet from overheating by soaking up greenhouse gases like carbon dioxide. So if polar ice starts to spread over high-latitude continents, the rocks can no longer soak up carbon dioxide because they are covered by ice. The gases,

instead, linger in the atmosphere, causing greenhouse warming, thereby forcing the ice to retreat. The rocks then absorb the carbon dioxide and stability is restored.

Yet with the continents draping the planet like a necklace, the ice could advance unchecked. Rainfall is much more intense in the tropics than in higher latitudes. "The more intense the rainfall, the more effective rocks are at trapping carbon dioxide. If all the world's continents were near the equator, their collective ability to suck up carbon dioxide would go into overdrive" (Walker, 2003, 259-260, n.2). Less carbon dioxide means more cooling; more cooling means more ice; and more ice means yet more cooling. These conditions explain why the Snowball occurred on two separate occasions and why, between 750 and 590 million years ago, there was a series of Snowballs rather than just one. With all the continents arranged in a band around earth's equator, a

[s]nowball would begin when some trivial cooling set the ice moving. With no high-latitude continents to stop it, the ice would continue until the earth was encased. Over the next 10 million years or so, carbon dioxide gas pouring out of volcanoes would build the atmosphere into a furnace, until it became so hot that the ice melted back. Gradually, then, the carbon dioxide levels in the atmosphere would drop, until the whole process started again. As long as the continents stayed near the equator, another cooling trigger would set another Snowball rolling. And another. And another. Until, eventually, the continents moved on and the world was spared (Walker, 2003, 238).

If all these explanations are true, Snowball earth is an exemplary embodiment of the movement from sheer possibility to absolute necessity. The sheer possibility is the random drift of continents. Real possibility and real necessity are grounded by this contingent event. The Snowball emerges from coalescing conditions and circumstances - the behavior of rotating objects, hot rock plume forming underneath a supercontinent, the supercontinent being blown to bits and spread around the tropics, the fact that the tropics absorbs the bulk of sunlight reaching earth, land reflects heat more than water, rainfall is intense in the tropics, rainfall causes rocks to soak up CO₂ more rapidly, all

this causes cooling, cooling sets ice in motion, ice reflects sunlight, leading to more cooling, rocks covered by ice do not absorb carbon dioxide, carbon dioxide builds up in the atmosphere, leading to extreme greenhouse conditions, the ice melts...then repeat the process. Given all these conditions it was necessary that the earth became encased in a sheet of ice for millions of years. It was also absolutely necessary that this state of affairs come to an end. Since conditions are always in flux, absolute necessity dictates that finite, contingent conditions must cease to be. In this flux of conditions, when the continents moved all the other conditions changed and the Snowball was no more.

This, however, is not the end of the contingency and necessity of Snowball earth. Life somehow held on throughout the Snowball -- throughout temperatures ranging from minus 40 degrees C (minus 72 degrees F) to temperatures soaring to 40 degrees C. The greenhouse effect created by spiraling CO₂ levels caused by volcanic eruptions was "beyond the wildest imagination of any oil conglomerate" (Walker, 2003, 98). "Intense hurricanes flooded the surface with acid rain. Oceans frothed and bubbled, and rocks dissolved like baking powder" (20). All the greenhouse gases that had built up in the atmosphere, with CO₂ concentrations that were perhaps one hundred times what they are today, were now in the rain. The rain laced with CO₂ ground the earth's surface into one big Dust Bowl. This process would have continued for tens of thousands of years until the CO₂ became locked up again inside the rocks that managed to remain. Needless to say, life somehow survived this hell on earth. Moreover, Snowball earth and its disintegration had to have wiped the slate clean and created new conditions, much as, after the K-T event, tiny mammals were able to occupy ecological niches dominated by dinosaurs for hundreds of millions of years.

Complex, multicellular life might have evolved before the Snowball and managed to hang on by clinging to sunlight under the ice in the tropics or in melt pools, though there is no fossil record of complex life (besides algae) from before the time of the Snowball. In any case, whatever life managed to survive undoubtedly did so in this manner. As mentioned, the fossil record for the emergence of complex life is uncannily close to the end of the last Snowball. Complex life did not emerge from the first Snowball, two billion years ago, because for evolution to speed up "living things don't just need the environmental opportunity [or conditions], they also need the genetic wherewithal. Genetic material changes through time and chance, and the creatures living during this early Snowball may not yet have had long enough to string together the genes they'd eventually need" (Walker, 2003, 259, n.1). In other words, complex life did not emerge from the first Snowball because the conditions and circumstances were not right. With regard to these conditions, we know that evolution tends to pick up its snail's pace, shown in the passages above from Darwin, after a bottleneck. Such was the case with the K-T event. And such was the case with human beings. Evolutionary bottlenecks bear out Hegel's rather macabre point that death, negation, and destruction are absolutely necessary in order for new forms of life to evolve.

The evidence strongly suggests that there was a rather severe bottleneck in the history of *homo sapiens*. We know this because there is very little genetic diversity among human beings. There is more genetic diversity among a troupe of baboons in Africa than there is among any two human beings currently alive on the planet. A small amount of genetic diversity means that a species has recently experienced a dangerously low level in its population and has yet to replenish its genetic diversity. The human

population probably bottlenecked around 74,000 years ago with the eruption of the supervolcano Toba in Sumatra, Indonesia. Supervolcanos make ordinary volcanoes like Mount Saint Helens look puny. Toba spewed out enough ash and aerosols to cause global cooling from 3 to 5 degrees C, and perhaps as much as 10 degrees C in some places. While it is true that volcanoes emit vast quantities of carbon dioxide into the atmosphere, the massive quantities of sulfur dioxide initially absorb incoming infrared radiation, preventing it from ever entering earth's atmosphere in the first place. Toba led to perhaps decades of what is now known as a nuclear winter; yet another instance of global climate change. Four species of hominids managed to survive these conditions -- *homo neanderthals*, *homo erectus*, *homo floresiensis*, and *homo sapiens*. Estimates vary, but the number of *homo sapiens* immediately after Toba could have dropped to as few as a couple thousand (hence the small genetic diversity). Soon after the bottleneck, however, *homo sapiens* flourished like never before. Tool use became significantly more advanced, cave paintings began to appear, and language probably began to develop.

The specific mechanisms through which a bottleneck leads to speeding up evolution have yet to be determined. Yet there is an undeniable correlation. As we can see, an evolutionary bottleneck is a clear example of Hegel's absolute necessity. "What is absolutely necessary in this world of contingency...is negation, destruction, death" (Houlgate, 1995, 46). So, in the case of the Snowball, the pre-existing multicellular life that managed to survive might have bottlenecked and then thrived under the new conditions. Or, alternatively, single-celled organisms -- which also, undoubtedly, bottlenecked -- might have found post-Snowball conditions such that they could, or had to, develop into multicellular organisms.

The point of all these examples is to show that Hegel's category of "Actuality" is at work **in** nature. Contingency and necessity are not mutually exclusive. As was the case with likeness and unlikeness, contingency and necessity *are the same thing*. Prospectively, the course of events depicted above is entirely contingent. They could have been otherwise; the only thing that is necessary is contingency itself. Retrospectively, given the conditions, the course of events could not have been otherwise. We arrived at where we currently stand in natural history by a means analogous to tossing 693 unbound pages of *War and Peace* into the air, gathering them in a neat stack, and arriving at a certain arrangement: specifically, through a union of contingent conditions and necessary outcomes of these conditions.

Natural laws necessarily manifest themselves in one way or another under certain conditions, and the confluence of conditions is a matter of contingency. Since, of course, conditions have their conditions in antecedent conditions, the whole block of conditions is necessary. Hegel is getting at this very thought in the following section, "The Absolute Relation."

The Absolute Relation

At this point in the *Science of Logic* substance, so defined, is the relation among the entirety of contingent conditions. The contingent conditions are the flux of accidents. A flux of accidents can be made intuitive by considering all the "accidents" discussed above -- continental drift, Snowball Earth, the K-T event, ice ages, the eruption of Toba. Hegel maintains that substance "is the totality of the whole and embraces accidentality within it, and *accidentality is the whole of substance itself*" (556, my emphasis). The Absolute Relation describes the relations among accidents and, in this manner, is

purportedly the coming-to-be of substance itself. Substance is the *totality* of all its conditions, or what I just dubbed 'the whole bloc of conditions.'

In the Absolute Relation, Hegel is trying to incorporate Kant into the overall movement of the *Logic*. Kant's relational categories are third in his "Table of Categories" in the *Critique of Pure Reason*. The first set of categories is *Of Quantity*, the second *Of Quality*, and the fourth *Of Modality*. The latter involves what we just discussed: possibility-impossibility; existence-non-existence; necessity-contingency (see B106 in the first *Critique*). *Of Relation*, then, completes the list.

Findlay describes Hegel's account of the first absolute relation, formal causality, as "rather perverse" (1958, 216). Formal causality is basically the same as real ground. The cause and the effect have identical content. For instance, the cause of increased CO₂ concentrations in the atmosphere is increased CO₂ emissions. Or rain is the cause of moistening the things it wets. As Hegel puts it, "effect contains nothing whatever that cause does not contain. Conversely, cause contains nothing which is not in its effect" (559). And, as we have seen, an inner force is tantamount to its outer expression: "the cause of an *act* is the inner disposition in an active subject, and this is the same content and worth as the outer existence which it acquires through the deed" (561). In other words, the dispositional nature, or tendency of certain events to emerge under certain conditions is found **in** the emergence of these events. So far, then, Hegel has told us nothing new, apart from the addition of an *inner disposition*, which will be a major player later on.

The determinate relation of causality offers some fresh insight. In this section Hegel holds that the effect turns back on the cause. Hegel puts the point in his usual

tongue-twisting style: "the cause has an effect *and is at the same time itself effect*, and the effect not only has a cause but *is also itself cause*, yet the effect which the cause *has*, and the effect which the cause *is*, are different, as are also the cause which the effect *has*, and the cause *which the effect is*" (566). The qualification that cause and effect "are different" separates the determinate relation of causality from formal causality.

The basic idea is this. Look again at the feedback loops in Figures 1-13 and 2-10. A cause of global climate change is socio-economic relations among human beings. The effects of global climate change are environmental and economic impacts, with their attendant suffering and death. The effects will eventually circle back upon the cause, socio-economic relations among human beings. This can be seen by following the loops in Figures 1-13 and 2-10. In this way, the effect (impacts) becomes a cause and the cause (socio-economic relations among human beings) becomes an effect. We can easily maintain that the impacts of climate changes are causes that bring about certain effects -- hopefully, a change in socio-economic relations among human beings. As in Figures 1-13 and 2-10, each time you go through the loop a different outcome obtains; there is, roughly, more or less global warming, more or less impacts, more or less emissions, and the like. This is what Hegel means in the tongue-twisting passage. A cause is, in turn, an effect of its own effect; or in other words, the initial effect is a cause that acts upon what caused it.

In describing cause and effect, we have described Hegel's notion of action and reaction. Hegel speaks here in terms of active and passive substances, but the general idea is the same. In fact, action and reaction recapitulates force and its solicitation, with the additional twist of the determinate relation of causality. An active substance, or

force, acts upon a passive substance. The passive substance, or force, reacts by acting upon the active substance. Therefore, the passive substance is active (it acts upon the substance that acted upon it) and the active substance is passive (it is acted upon by the substance that it initially acted upon).

This relation is obviously one of reciprocity, the final category of the absolute relation.

...reciprocity displays itself as a reciprocal causality of *presupposed, self-conditioning substances*; each is alike active and passive *substance* in relation to the other. Since the two, then, are both passive and active, any distinction between them has already been sublated... they are substances only inasmuch as they are the identity of the active and the passive (569).

Framed in terms of substances, it is easy to see that the active and passive substances acting upon each other are not two different substances. Since the active substance and the passive substance turn out to be *the same thing*, they form *one* substance -- an Absolute Substance. This Absolute Substance is the Notion. The Notion simply *is* all these influences and relationships we have discussed to this point. It *is* the flux of accidents. As we have seen, the course followed by contingency is a necessary course. "Necessity does not become *freedom* by vanishing, but only because its still *inner* identity is *manifested*, a manifestation which is the identical movement of the different sides within themselves ... (571). Everything that has occurred in the *Logic* thus far has been the outer manifestation of the inner identity, or inner disposition, of the Notion. And the Notion is the totality, the whole, resulting from all these reciprocal relations. Clearly, the Notion itself should also exhibit reciprocity. Its outer manifestations are the result of the Notion's inner disposition; and the Notion is a result of its outer manifestations, the system of relations we have discussed thus far in the *Logic*. There are

no outer manifestations without the inner disposition of the Notion, and there is no inner disposition of the Notion without outer manifestations.

This latter idea may seem counterintuitive, but it is quite plausible. We have seen that according to Hegel a "law" of nature is that something is predisposed to act a certain way under certain conditions. Our exact words, as we put it in formal causality, were that 'the disposition of certain events to emerge under certain conditions is found **in** the emergence of these events.' The string of events that led to Snowball earth and its apocalyptic meltdowns shows this quite clearly. But you don't know, for instance, that somebody is predisposed to something until what they are predisposed to becomes manifest. If you claimed that all the prisoners on death row in the state of Texas are predisposed to violence you'd probably be right. But how do you know if someone is predisposed towards violence unless that person exhibits violent behavior? You may be genetically predisposed to high cholesterol, but this cannot be demonstrated until your cholesterol level becomes unsafe. If you had a family history of high cholesterol, and your cholesterol levels never became high because of diet and exercise, it cannot be demonstrated that you are genetically predisposed to high cholesterol. For all you know, you might not be genetically predisposed to high cholesterol and you could have been eating whatever you wanted. By the same token, it is meaningless to assert that earth is predisposed to becoming a Snowball unless earth had actually become a Snowball. As Hegel asserted in "The Solicitation of Force," coalescing conditions solicit, or draw out, inner predispositions. So again, in Hegelian terms, there are no outer manifestations -- no system of relations which *is* the *Logic* -- without the inner disposition of the Notion, and there is no inner disposition without outer manifestations. I have emphasized this point

because Volume Two, "Subjective Logic or The Doctrine of the Notion" is devoted exclusively to delineating the realization or actualization of the inner disposition of the Notion.

On a less speculative level, we should be impressed by one striking feature of Hegel's account: the interconnectedness of all things. That you are reading this sentence right now might be the result of the fact that the earth was encased in a sheet of ice hundreds of millions of years ago. That you walk on two legs and have an enormous brain is a result of genetic and environmental conditions millions of years ago. That there is human civilization is a result of a warm period more stable than any period in the past 400,000 years. That I am typing this sentence on a computer is probably a result of the fact that the supervolcano Toba in Indonesia erupted some 75,000 years ago. One could suggest that the same results could be obtained via a different route or routes, but the odds are greatly against it.

In the latter half of the Doctrine of Essence, I have focused on different types of global climate change. We are in position to do something about the climate change already under way. Hegel explains how in the Doctrine of the Notion, specifically in the sections "Mechanism," "Chemism," and "Teleology."

CHAPTER V

THE DOCTRINE OF THE NOTION

"To me the question of the environment is more ominous than peace and war...I'm more worried about global warming than I am of any major military conflict" (U.N. weapons inspector Hans Blix, March 14, 2003; quoted in Gelbspan, 2004, 153).

"If Kant had considered the Idea of an *intuitive understanding* in light of the above definition of truth, he would have treated the Idea which expresses the required agreement, not as figment of thought but rather as the truth" (*Science of Logic*, p. 593).

I will not discuss in any detail the first three chapters of "Section One: Subjectivity." I would, however, like to cite a few passages that have a particular bearing on the relation between the Idea/Notion and nature. I will also briefly address "The Notion" of Chapter 1, in which Hegel spells out the relation between the universal Notion, the particular Notion, and individuals. This should bring our discussion of the cat-example to a conclusion.

We saw at the end of the Doctrine of Essence that the system of relations we have been discussing hitherto has been the external expression of the inner disposition of the Notion. Why does the Notion express its inner disposition? Hegel's answer is that it just does. That's what it means to have an inner disposition. Asking this question is like asking why the three angles of a triangle always add up to 180 degrees. In "The Notion in General" Hegel avers: "Now it must certainly be admitted the Notion *as such* is not yet complete, but must rise to the *Idea* which alone is the unity of the Notion and reality; and this must be shown...to be the *spontaneous outcome of the nature* [or inner

disposition] *of the Notion itself* (587, original emphasis). Nature, too, is the spontaneous outcome of the inner disposition of the Notion: "logic exhibits the elevation of the *Idea* to that level from which it becomes *the creator of nature* and passes over the form of a concrete immediacy" (592, my emphasis). Again, the Idea is the creator of nature. This passage is of a piece with the passage I placed at the head of the chapter concerning an intuitive understanding. Kant held that it certainly looks like nature was created by some sort of intellect, given its intricacies and organization, but we finite humans, with our limited intellect, are not privy to knowing this. Hegel chastises Kant for not planting a divine intellect in nature. Hegel holds, as we have seen, that nature is formed out of Reason. Reason, or the Idea, is the understanding of the intuitive understanding. The intuitive part is nature itself, in all its material, sensuous manifestations. As I argued in the Introduction, when the real processes of nature do not correspond to a category of the Idea, this is due to the impotence of nature. These are mere contingencies of nature, or as we saw in "The Determinations of Reflection" they are the diversity of nature. Hegel returns to this thought in the "particular notion."

In *nature*, of course, there are to be found more than two species in a genus.... This is the impotence of nature, that it cannot adhere to and exhibit the strictness of the Notion and runs wild in this blind irrational [*begrifflos*, notionless, without a concept or category] *multiplicity*. We can *wonder* at nature's manifold genera and species and the endless diversity of her formations, for *wonderment* is *unreasoning* [*ohne Begriff*, without a concept or category] and its object the irrational. Nature, because, it is the self-externality of the Notion, is free to indulge itself in this variety, just as spirit, too, even though it possesses the Notion in the shape of the Notion...The manifold natural genera or species must not be esteemed as anything more than the capricious fancies of spirit in its representations. Both [nature and spirit] indeed show traces and inklings of the Notion on all sides, but do not present a faithful copy of it because they are the side of its free self-externality. The Notion is absolute power [*absolute Macht*] just because it can abandon its difference to the shape of self-subsistent diversity, outer necessity, contingency, caprice... (607,608).

This passage pretty much says it all. The Doctrine of the Notion deals with the *logical* aspects of the self-externality of the Notion. That a "strict" Notion abandons

itself **in** blind necessity, contingency, self-subsistent diversity, etc. is a testament to the Notion's absolute power. The Notion can even reign in that which is not *strictly* logical and rational, namely nature. What is more, the Notion *spontaneously creates* that which is not strictly logical and rational, since the Idea is the creator of nature; a further testament to its absolute power. The Notion is so powerful that it lets nature, its own self-externality, "indulge in this variety," much as a strong, healthy organism is not affected by the diseases or sickness that enters into it.

We have already seen part of the logical form of nature in the Introduction, with our cat-example and the general discussion about the relation between abstract, universal categories and materially existing individuals. Hegel covers this in Chapter 1, "The Notion." Here, of course, he is discussing *logical* individuals, but this nuance need not concern us.

The Universal Notion is abstract universality. By this Hegel means that the universal lacks a context or any concrete embodiment. It is the category "cat" apart from any of the cats that have ever walked upon the face of the earth. Now, as we saw in the Introduction, there can be no universal category without its concrete embodiment, just as there can be no inner disposition without an outer manifestation. The concrete embodiment is found **in** all materially existing cats. This is the particular notion. As we phrased it in discussing the cookie-cutters and the dough with form, matter, and content, the particular notion -- as a development of the universal notion -- is that which carves up material reality. As Houlgate put it, it is the "immanent *a priori* logical form of nature." The particular notion is that which makes a certain chunk of material reality "cats." It is what all cats have in common irrespective of the *diversity* among cats. In Hegel's own

words, "The particular contains universality, which constitutes its substance; the *genus* is unaltered in its species, and the species are not different from the universal but only *from one another*. The particular has one and the same universality as the *other* particulars to which it is related" (606). The difference between the universal and the particular is that the universal is, if only in principle, separate from its concrete embodiment -- the universal is abstract -- whereas the particular is not even in principle separate from its concrete embodiment.

The Individual is obviously individual cats or, more precisely, the universal notion as it expresses itself in individual cats through the particular notion. As always with Hegel, the relation between universal, particular, and individual is a package deal. The universal *automatically implies* its concrete manifestations in individuals through the particular notion. And the individual *automatically implies* that it is an instance of a universal, unless of course the impotence of nature supervenes. Hegel elaborates on the formal or subjective relations between this triumvirate in the "The Judgment" and "The Syllogism." The relations are subjective because they concern how we think about objectivity rather than objectivity itself. He then returns to "Objectivity" proper in "Mechanism." We pick up the *Logic* at this point.

Mechanism and Chemism

The basic idea of mechanism is very simple. One object acts upon another, which then acts upon another, which acts upon another...and so on in a chain reaction. One need only think of those comedy routines in which, for instance, a guy walking down some stairs spills some golf balls out of golf bag; the person behind him trips into

someone else; that person slams into some one holding a bunch of loose papers, perhaps the 693 unbound pages of *War and Peace*; after promptly throwing the papers in the air that person slams into someone else; who then runs into someone else; who then pushes someone sitting at a counter; that person's face is propelled forward into a big cream pie; the person with pie all over his face stands up and his pants fall down to reveal his oversized polka-dot boxers.

Curiously, both the climate change currently under way and Snowball earth proceed in exactly the same way; the way in which spilled golf balls result in a face full of pie. In the former, fossil fuels are extracted from the ground; they are burned and release CO₂; the CO₂ builds up in the atmosphere; increased CO₂ concentrations prevent infrared radiation from escaping; the world warms; climate patterns alter; and the environment, human beings, and other species are affected. The chain reaction in Snowball earth has a few more links, but the basic principle is the same.

Hegel provides the big picture in the following passage:

Thus the object, like any determinate being in general, has the determinateness of its totality *outside it* in *other* objects, and these in turn have theirs *outside them*, and so on to infinity. The return-into-self of this progression to infinity must indeed likewise be assumed and represented as a *totality*, a *world*; but that world is nothing but the universality that is confined within itself by indeterminate individuality, that is, a *universe* (713).

Mechanism is universal -- that is, it *constitutes* the universe -- in that it is at work in each individual object. And each individual object is put in motion, or "has its being," in *other* objects. Every object depends on the previous link in the chain. This is why mechanism is merely an "external determination." For Hegel, of course, this is entirely unacceptable. As we have seen throughout, the otherness or external

determination must be roped back in and subsumed under a more general principle. Thus Hegel calls for a "return-into-self" in mechanism's progression to infinity.

Hegel lays the ground for a return-into-self in the following passages. "So far, then, what is communicated remains what is; it merely *distributes* itself to the objects or is determined by their particularity. The cause gets lost in its other, the effect...[T]he object asserts its externality in the face of *communicated universality*...Now the first moment of this real *process* is...*communication*" (717, 719). Objects affect one another in a certain way because they communicate certain forces, or affinities, with each other. We saw above that objects relate to each other according to their physical composition. At issue in mechanism and chemism is the material medium through which objects relate to each other. In the comedy routine above, the material medium is nothing other than the force of motion, beginning with spilling golf balls and ending with someone's face in a pie. In climate change, the material medium is chemical reactions. For instance, the more intense the rainfall, the more effective rocks are at soaking up carbon dioxide. If all earth's land masses are at the equator, where rainfall is more intense than anywhere else, rocks would go into collective overdrive in soaking up carbon dioxide. This, in turn, would lead to cooling. And cooling may lead to glacial expansion. Here we have a mechanical process -- each element is set in motion by elements outside it -- that is bound together by a series of chemical reactions.

Burbidge describes the transition from mechanism to chemism this way.

When we think of the objective realm *mechanically*, we understand it to be made up of independent objects which, if they are altered at all, do not move themselves, but are acted upon...any such movement must come from other objects. So we have a diversity of mechanical entities, each one moved only by movement of the others; each responds and in turn acts on the others. There is, then, a reciprocity of action and reaction [as described above, at the very end of the Doctrine of Essence].

The laws that emerge from mechanism spell out the way mechanical objects relate to each other. Each is no longer defined as strictly independent, simply responding to external forces, but rather as oriented towards an other. Such a way of conceiving the objective realm, however, is no longer strictly mechanical, for it presupposes an attraction between opposing objects. To view objects not as independent, but as oriented towards each other in this way, is to conceive them not mechanically but chemically (1996, 78-79).

Any object's "orientation towards an other" depends on its physical composition. And the physical composition of an object determines how it relates, chemically or otherwise, with other objects. The person on the steps probably would not have tripped on golf tees that fell out of the bag, or on a scorecard or one of those half-pencils. Likewise, rocks soak up carbon dioxide during increased rainfall because of their physical composition. The rocks are "oriented" towards the rain and carbon dioxide, just as carbon dioxide is "oriented" towards infrared radiation (and vice-versa). So the material medium through which objects relate to each other, through which objects are "oriented towards each other," is built into the respective physical compositions of objects or molecules, as the case may be. Perhaps the most prominent chemical process we have discussed is the one that ushered in the Anthropogenic era, which is the era of human influence on the climate: CO₂ is released when carbon-rich fuels are burned for energy.

Clearly, our explanation of climate change could stop here. On its most basic level, everything that we have discussed, from emissions to impacts, is a mechanical and chemical process. All aspects of climate change operate according to certain physical principles, all the way down to the capacity of species, including humans, to adapt to climate change. For Hegel, however, mechanical and chemical processes cannot stand alone. They must be determined by *something else*. "Of course mechanism, at least the ordinary *unfree* [my emphasis] mechanism, and also chemism, must be regarded as an immanent principle in so far as the *external* determinant is itself *again just such another*

object, externally determined and indifferent to such determining, or, in the case of chemism, the other object is one likewise chemically determined; in general, *an essential moment of the totality always lies in something outside it*" (735). Hegel reveals what that something else is, the totality outside mechanical and chemical processes, in the first sentence of "Teleology." It will of course turn out that the totality is not totally outside mechanical and chemical processes.

Teleology

"Where *purposiveness* is discerned, an *intelligence* [*Verstand*, understanding] is assumed as its author, and for the end we therefore demand the Notion's own free existence." So goes the first sentence of "Teleology." "Teleology is especially contrasted with *mechanism*, in which the determinateness posited in the object, being external, is essentially one in which no *self-determination* is manifested" (734). So goes the second sentence in "Teleology." Teleology is contrasted with mechanism and chemism because teleology stands outside these processes even as it involves these processes. Teleology is a plan, purpose, or design that sets mechanical and chemical processes in motion. This involves, at minimum, some sort of intelligence at work in nature. Or, to put the point differently, the Notion *is* nature. The Notion is not separate from nature because it is infinite. If the Notion were not in every single blade, it would be finite. Hegel writes: "The more the teleological principle was linked with the concept of an *extramundane* intelligence and to that extent was favored by piety, the more it seemed to depart from the true investigation of nature, which aims at cognizing the properties of nature not as extraneous, but as *immanent determinateness* and accepts only such cognition as valid *comprehension*" (735).

The Notion is the overarching purposiveness of nature, or the overarching teleological necessity I mentioned in the Introduction. This purposiveness is carried out through natural purposes **found in** nature. Hegel credits Kant for emphasizing the *internal* purposes of nature. "One of Kant's great services to philosophy consists in the distinction he has made between relative or *external*, and *internal* purposiveness; in the latter he has opened up the Notion of life, the idea..." (737).

In addition to not planting a divine intelligence *in* nature, Hegel thinks that there is one other significant shortcoming of Kant's view. Kant thought that teleology and mechanism were mutually exclusive. If real processes happen only according to cause and effect, like the chain reactions described above, there is no room for any design or purposes. Although we can *think of* nature as having purposes which govern mechanical and physical processes, according to Kant we cannot just help ourselves to the claim that there are actually purposes **in** nature. We can talk *as if* there were purposes in nature, but it is illegitimate to go so far as to ascribe teleological purposes to nature.

By natural purposes Kant meant roughly what Aristotle called "final causes." A final cause works like this: $A \rightarrow B \rightarrow C \rightarrow A$. Say A is what German biologists, after Kant, called a *Bauplan*, a building plan or structural design of the organism. A is the overall structure of the organism, or the whole. For A to change it has to change the parts of which it is comprised. As we have seen repeatedly, to change the whole one must change the parts. So *A itself*, the *Bauplan* or structural design, sets B and C, the parts, in motion. B and C are mechanical and chemical processes. That A changes its own structure is a teleological principle. The *Bauplan* carries out a modification of its own design. Therefore A is both the cause and effect of itself. A is the cause of itself in that

the first A sets B and C, mechanical and chemical processes, in motion. A is the effect of itself in that it is the outcome of what happens when B and C are set in motion.

Likewise, A is both the cause and effect of B and C. Lenoir explains: "In contrast to the mechanical model where A can exist and have its effect independently of C, in the teleological model A causes C but is not also itself capable of existing independently of C" (1982, 25). This means that the parts are dependent upon the whole and the whole is dependent upon the parts. In Kant's own words,

Now in order for a thing to be a natural purpose it must meet two requirements. *First*, the possibility of its parts (as concerns both their existence and their form) must depend on their relation to the whole. For since the thing itself is a purpose, it is covered by [*befasst*] a concept or idea that must determine a priori everything that the thing is to contain...

A *second* requirement...is that the parts of the thing combine into the unity of the whole because they are reciprocally cause and effect of their form. For only in this way is it possible that the idea of the whole should conversely (reciprocally) determine the form and combination of all the parts...(1790, sect. 63, 373).

A natural purpose is a concept or idea, or idea of the whole, that determines the arrangement of the parts. In turn, the arrangement and interaction among the parts determines the whole. On Kant's view, we can use this concept or idea of the whole in making judgments about nature, *as if* nature actually contained such natural purposes, but we cannot take natural purposes to be *determinative of* nature. "Kant was willing to admit, indeed he was strongly committed to the notion, that all natural products *come about* [my emphasis] through natural-physical causation...But what Kant insisted upon is that if nature somehow uses mechanical means in constituting organized bodies, and even if the process is capable of technical duplication, we are nevertheless incapable of understanding that constitutive [or determinative] act from a theoretical scientific point of view" (Lenoir, 1982, 25-56). "The principles of mechanics are applicable to the analysis

of functional relations," Lenoir continues, "but the teleological explanations demanded by biology require an active, productive principle which transcends any form of causal (natural, physical) explanation available to human reason" (26). The active, productive principle is the idea of the whole or a concept -- a natural purpose. The teleological movement of natural purposes, of $A \rightarrow B \rightarrow C \rightarrow A$, is "the theoretical construction of organized bodies that Kant claimed must remain forever intractable" (27).

Hegel goes right ahead and inserts into nature the active, productive principle which transcends and governs mechanical and chemical processes. What Kant called "a concept or idea that must determine a priori everything that the thing is to contain" becomes for Hegel, as Houlgate has phrased it, "the *immanent* a priori logic of nature;" the operative word being "immanent." This follows from the fact that Hegel holds that the Notion or Absolute is **in** nature, or more appropriately, *is* nature. Kant had maintained that

...when we deal with those products of nature that we can judge only as having intentionally been formed in just this way rather than another...we cannot even think [these products of nature] as organized things without also thinking that they were produced intentionally.

Now if we present the existence or form of a thing as possible [only] under the condition [that there is] a purpose, then the concept of the thing is inseparably connected with the concept that the thing is contingent (in terms of natural laws). That is also why those natural things we find possible only as purposes constitute the foremost proof that the world as a whole is contingent [again, contingent means governed by natural laws], and are the sole basis for a proof that holds both for common understanding and for the philosopher: that this whole depends upon and has its origin in a *being that exists apart from the world* [my emphasis] and (given how purposive these forms are) is moreover intelligent. Hence these things are the sole basis for the proving that teleology cannot find final [*Vollendung*] answers to its inquiries except in a theology (1790, sect. 75, 398-399).

For Kant, natural purposes provide evidence for and have their origin in an intelligent designer that exists apart from the world. For Hegel, natural purposes are the expression of the Notion, and the Notion simply is the world. Again, Hegel sees no problem with

inserting into nature the teleological principle of Kant's "idea of the whole," along the final cause of the whole-parts relation. Teleology works with mechanism in the form of natural purposes. Teleology and mechanism are not mutually exclusive, as Kant maintains in the Antimony cited by Hegel (738-740.) Teleology and mechanism complement one another. The end, or final cause, is laid out by natural purposes. And the means through which the end is achieved are mechanism and chemism (which is how the parts relate to each other).

Although there are probably no natural purposes, in Kant and Hegel's sense, there is teleological activity in nature. It is the activity of human beings. According to Kant and Hegel, teleological activity in nature is supposed to work by the end, or the "idea of the whole," using mechanical and chemical means to realize this end. Human beings do this all time. We harness the power of nature through hydroelectricity, burning fossil fuels, making furniture, building houses, and exploding atomic bombs. In all these cases, we envision an end and then employ the mechanical and chemical processes of nature to realize this end.

Sometimes the means used to accomplish certain ends become ends themselves. Hegel remarks: "To this extent the *means* is superior to the *finite* ends...: the *plough* is more honorable than are immediately the enjoyments procured by it and which are ends. The *tool* lasts...In his tools man possesses power over external nature, even though in respect of his ends he is, on the contrary, subject to it" (747). The plough is a means for growing food, but making good plows is also an end because without the plough it would be more difficult to grow food.

We could even speculate about the very beginnings of human, or proto-human, teleological activity. On Marx's view, human beings

must be in a position to live in order to be able to 'make history.' But life involves before everything else eating and drinking, a habitation, clothing and many other things. The first historical act is thus the production of the means to satisfy these needs, the production of material life itself. And indeed this is an historical act, a fundamental condition of all history, which today, as thousands of years ago, must daily and hourly be fulfilled in order to sustain human life (1999, 48).

According to Marx, the very first act in human history was when someone produced a means to realize an end, the end being the basic requirements of survival. For Marx, the first historical act in human history is a teleological act.

Stanley Kubrick's *2001: A Space Odyssey*, which could be viewed as a history of teleological activity, depicts this point perfectly. At the very beginning of the film one of the simians around the waterhole picks up the bone of a wildebeest and uses it to kill a simian of the rival group. In Marx's estimation, this very well could be the first historical act. The bone has become a tool, a means, to realize an end. The end is to obtain exclusive access to the waterhole and thus to satisfy the needs of material life. Then the simian throws the bone into the air and, in the famous jump-cut, the bone turns into a spaceship. At the end of the film, the purportedly infallible supercomputer HAL turns against the astronauts aboard the spaceship when "his" infallibility is called into question. HAL is the pinnacle of human teleological activity, of producing means to realize ends; activity that began with the simian slaying a rival with the bone of wildebeest. Instead of human beings controlling the supercomputer HAL, HAL controls the destiny of "his" designers. This very well could be the final irony of Hegel's point that the means becomes more important than the end which it is supposed to serve.

The Idea

We have come to the end of Hegel's *Science of Logic*. It's been a long, strange trip. Not surprisingly, Hegel holds that "the Idea is the unity of the Notion and objectivity" (756). The end-oriented teleological activity discussed in the previous chapter, of humans and the rest of nature, is the teleological activity of the Idea. Like the inner disposition of the Notion, the Idea is "its *own end* [*Selbstzweck*, self-actualizing potentiality] and the *urge* [*Trieb*] to realize it" (758).

We noted at the beginning that as the *Logic* progresses its content becomes more determinate. The *immediate* content of the Idea is life. The immediate content of the Idea is not natural life, "which is dealt with in the *philosophy of nature*," and it is not "life in so far as it stands in connection with *spirit*;" it is something Hegel calls "logical life as pure Idea" (762). It is only appropriate that Hegel should save his weirdest concept until the very end. At first, in the living individual, the "Idea of life in its immediacy is as yet only the creative universal soul" (764). The creative universal soul of logical life is the above mentioned urge or drive [*Trieb*] to realize certain forms of life. This drive proceeds throughout "the living individual," "the life process," and "the genus." Hegel sums matters up near the end of "Life."

It is thus the individuality of life itself, *generated* [original emphasis]...from the *actual* Idea. In the first instance, it is itself only Notion that has yet to objectify itself, but it is *the actual Notion -- the germ of the living individual*. The germ...demonstrates that the *subjective Notion* has *external actuality*. For the germ of the living being is the completed concretion of individuality, in which all its diverse aspects, properties and articulated differences are contained in their *entire determinateness*, and the initially *immaterial*, subjective totality is undeveloped, simple and non-sensuous; the germ is thus the entire living being in the inner form of the Notion (774).

This passage encapsulates nicely Hegel's metaphysics. The germ is the subjective end prescribed in advance, the natural purpose, the acorn that is fated to become an oak --

given certain conditions. Note that the germ is *immaterial*. It is the inner subjective form of the Notion. As the germ develops, as it realizes its natural purpose, the form is filled out with material, sensuous, content. Put differently, the immaterial subjective form is *developed through* objective content. Spurred by its urge to realize itself, the end does so through certain conditions, through its interaction with the environment. It is in this way that logical life is the actual Idea or external actuality.

Everything in the *Science of Logic* hitherto has been the actualization of the "Absolute Idea," the title of the last chapter. As we stated in the opening paragraphs of "With What Must Science Begin," the *Logic* has swallowed up all its presuppositions. It has internally incorporated everything to which it is externally related. The last relation is to life itself. "The Idea, namely, in positing itself as absolute *unity* of the pure Notion and its reality and thus contracting itself into the immediacy of *being* is the *totality* of this form -- *nature*" (843). In the passage above, from "Life," "the subjective Notion in its totality *becomes objectivity*, and the *subjective end becomes life*." Now, however, with the Absolute Idea, "the pure Idea in which the determinateness or reality of the Notion is itself raised into Notion, is an absolute *liberation* for which there is no longer any immediate determination that is not equally itself *posited* and itself Notion...the Idea *freely releases* itself in its absolute self-assurance and inner poise" (843). That life, or logical life, is no longer an immediate determination of the Idea means the life is *mediated by* the Idea. As we saw again in "With What Must Science Begin," everything contains both immediacy and mediation. When logical life is fully mediated by the Idea, the Notion "liberates" or "freely releases itself" as natural life.

Natural life is the offshoot of logical life. As I argued in the Introduction, the Idea permeates nature with its pre-logical determinations. Pre-logical determinations are simply variations of logical life on a lesser level. Naturally, one may wonder: how can the Idea permeate nature with pre-logical determinations when nature is the post-logical manifestation of the Idea. We have to bear in mind that Hegel's system is circular. Since it is circular, pre-logical and post-logical are the same thing. We could depict it this way: logical categories → nature → spirit → logical categories → nature... Nature is post-logical in that, although it is rooted in an immanent *a priori* logical form, nature is still a lesser grade of logical unity. Nature is pre-logical in that the ascending levels [*Stufe*] of unity in nature culminate in Spirit, and the ascending levels of Spirit -- art, religion, and philosophy -- culminate in the grasp of logical categories. So the end of the *Science of Logic* is both the beginning of something, nature, and the end of something, the process that leads from nature through spirit and back to the *Science of Logic*. And the cycle is completed.

As the World Warms...

Warming the world is a cycle that need not continue. I want to close the discussion by raising an issue Hegel never once mentions in the *Logic*: the future. I emphasized at the end of the Doctrine of Essence that one of the most important points in the account of relations given by the *Science of Logic* is the interconnectedness of all things. A few decades ago we learned that when you spray deodorant under your arm you are contributing to a hole in the ozone and thus to increased incidents of skin cancer and other ills. Similarly, as we drive around gas-guzzling SUV's and consume fossil fuels we are, in a very real sense, killing other people and animals and causing an untold

amount of suffering. You may not be thinking of this in the comfy confines of your SUV, but in effect such actions are morally revealing: we are stating that our comfort and wealth are more important than the basic survival of other human beings and animals. I don't mean for this point to take on a righteous tone of indignation. The question for the future is one of "intergenerational equity."

I have argued that we are morally obligated to prevent or mitigate suffering and death, especially when reasonable measures are available for doing so. According to this ethical principle, the suffering and death that we prevent can be that of human beings and other animals yet to be born. Intergenerational equity means that we are morally obligated not to leave future generations worse off. Admittedly, it is difficult enough to act on the moral obligations we have to living human beings and animals, let alone on obligations we have to those who may live hundreds of years from now. However, just as scientists' predicted in the early 1970's that the effects of global warming would begin to show themselves around the turn of the century, at the present pace we will probably begin to approach dangerous and irreversible thresholds of global warming sometime in the next century, if not before. On camping trips, my scoutmaster would always say about the campsite and its surrounding area: 'leave it better than you found it.' Intergenerational equity embodies this very principle. Hopefully, in the future, we will adopt this principle and act on it.

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