# The Construction of Knowledge and Implications for the Climate Change Debate:

## A Perspective from the Developing South

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**Abstract**

Central to the climate change debate is the way that we construct knowledge. Concepts are the basic building blocks around which complex knowledge systems are built. Yet the concepts that we use are value laden. The whole notion of 'global warming', for example, suggests that the planet was cooler at some time in the past and is now becoming warmer with possible devastating implications for humans. 'Climate change' suggests that dynamic equilibrium is an abnormal condition and conveys with it the subtle suggestion that the climate as we have come to know it is in fact the climax condition. These concepts are highly anthropocentric, all conveying as it were, the sense that humans are the pinnacle of all creation. The physical sciences generally fall into this category, with the underlying rationale being the desire (or the need) to control nature. In terms of this, the way that we construct our knowledge about climate change reflects this bias in a subtle yet unmistakable manner. There is a school of thought that challenges this anthropocentrism however. This school seeks to reintegrate humans into the environment, rather than see humans as separate from that environment. This presentation will seek to give an alternate angle to the climate change debate by focussing on the way that we have constructed our knowledge around the central conept of a 'resource'. A substantial portion of the current climate change debate is focussed on a change in the natural resource base - either in the form of an abundance such as flooding and sea level rise - or in the form of scarcity such as droughts and famine. This bias is what I shall call a first-order resource focus. In this case, a first-order resource is defined as a natural resource such as land and water. I shall then introduce the notion of a second-order resource, which is loosely defined as the ability of a given social entity to deal with changes to its first-order resource base. In constructing this new type of knowledge, the argument will be developed that while the current climate change debate is generally focussed on first-order resources, the real issues that should be receiving our scientific attention are the way that social entities deal with that rapid change. Given the fact that a large portion of the worlds population live in developing countries, most of which are characterized by significant population growth, coupled with the fact that the impact of climate change is likely to be severely felt in those same areas, makes this a worthwhile endeavour. As such, it will be argued, that for the developing world at least, a key area of research focus should be on the way that social entities deal with the impacts of climate change. In other words, we need to make a conceptual shift away from a first-order research bias towards a second-order research agenda if we are to construct knowledge that is useful for decision-makers in the developing world. This idea should be conveyed to scientists (and emerging scientists) in a way that they can understand. In short, we need to develop a discourse that is capable of functioning across scientific disciplines, and that is capable of withstanding the rigours of translation into different languages, if we are to have a profound understanding of the highly complex phenomena associated with climate change.

**Introduction**

Central to the climate change debate is the way that we construct knowledge. The very concept 'climate change' implies that something - in this case the climate - is changing. Inherent in this notion is a hidden value judgement. Changing climates seem to be somehow threatening to human beings so consequently we need to manage this perceived risk in some way or other. Concepts are the basic building blocks around which complex knowledge systems are built. Inherent within these concepts, and the way that we use them to construct knowledge, is an underlying assumption, and that assumption is invariably a manifestation of a power relationship of sorts. This paper seeks to open up the discussion on climate change, and in particular the way that knowledge is constructed as part of that overall discourse. The overall framework used will be that of political ecology, which will be used to analyze a component of the climate change discourse, the way we construct notions of what a 'resource' is. Due to the specific research interest of the author, water will be used as an example of a natural resource where appropriate. A reconstructed alternative discourse will be proposed from a political ecology perspective.

**Political Ecology**

Political ecology has existed for a long time, but has not always been given that name. Stott & Sullivan (2000:2) note that it has existed unconsciously from the moment people started to imagine environmental utopias and dystopias. As such it can be traced back from Virgil's The Georgics (29 BC), through the writings of Jean-Jacques Rousseau (1712-78) and Henry Thoreau (1817-62), to Tolkien's The Lord of the Rings. At its heart, political ecology is about the sense of politically located ideas of the environment and of the right sort of relationship of humans to and within it (Stott & Sullivan, 2000:2).

Stated simplistically, political ecology is about the construction of environmental knowledge, and in particular, about the underlying power relationships inherent therein. As such it provides a valuable analytical framework for this purpose. Political ecology is concerned with tracing the genealogy of environmental narratives, with identifying power relationships supported by such narratives, and with asserting the consequences of hegemony over those narratives (Stott & Sullivan, 2000:2). Political ecology tries to shift the focal point in intellectual debate away from the ideographic to the ideological and from the particular to the general, running in parallel with modern concerns about globalization (Giddens, 1990). As such, political ecology enables us to answer four key questions (Stott & Sullivan, 2000:2):

* Who currently holds power over influential narratives?
* How is this power employed and for what political purposes?
* What is the science that supports these defined narratives?
* What are the ideas of morality infusing these narratives and their supporting science?

These questions will be answered from a Southern perspective at the conclusion of this paper.

The way that we construct our knowledge impacts on the conclusions that we reach. Sullivan (2000) has shown that while western-styled notions of 'desertification' have been identified as the outcome of the disintegration of local-level resource management institutions in Namibia, very little scientifically-derived data has been used to support (or refute) this, because it was simply accepted as an undisputed fact or a self-evident truth. In the environmental field, there has been a philosophical change in perceptions of Nature and the environment, which may be characterized as a shift from a 'man at the mercy of nature' to a 'nature at the mercy of man' perspective - a view that has found a fruitful home in the global climate change debate (Bradnock & Saunders, 2000:67).

This political construction of environmental knowledge is clearly evident in the eco-feminist literature. It was initially based on the assumption that women would be appropriate agents for environmental protection, merely because they are often the visible victims of 'environmental degradation' (Dankelman & Davidson, 1988). A particular brand of this literature is that espoused by Shiva (1988), where it is argued that women act as natural 'intellectual gene pools' through their role as 'selectors and preservers of seed'. This argument is used to construct the notion that women are naturally suited for the conservation of bio-diversity (Jewitt & Kumar, 2000). As such, these images of the intimate relationship between women and the environment became an important foundation for the women, environment and development (WED) movement (Leach et al., 1995). For Shiva (1988), men's domination over nature has been translated into male domination over women which has excluded them from participating in both science and development (Jewitt & Kumar, 2000). This notion that women have a 'special' link to the environment in now being deconstructed by some authors (Leach et al., 1995) because of its misleading simplicity and political naïveté (Jewitt & Kumar, 2000). It is consequently necessary to go deeper than an understanding based on a direct linear relationship between humans - in this case women - and the environment, because inherent in such linkages are more subtle but no less important relationships of inequality, property rights and power. This has lead some commentators (Jewitt & Kumar, 2000) to conclude that while the WED/eco-feminist idea of a special link between women (humans) and Nature has been important in raising awareness of a certain category of environmental issues, there is also a real danger that this specific form of knowledge construction can divert attention away from a nuanced understanding about people and their relationship with the environment. Consequently, what is needed is a shift away from this simplistic construction of environmental knowledge, towards a more people-sensitive form of analysis that can unpack the issues inherent in the "highly political yet ever changing socially constructed nature of people-environment interactions" (Jewitt & Kumar, 2000:108).

**Scientific Discourse and its Manifestation in the Water Sector**

In order to start deconstructing the knowledge that we have created in the field of scientific endeavor, we need to understand the origins of the scientific method, because therein lies a valuable clue to understanding the global climate change discourse. The philosophical basis of modern science is to control Nature rather that to understand it (Turton, 1999). Understanding Nature is tolerated insofar as it enables Man to ultimately gain control over Nature. This is evident in the work of Francis Bacon (1620) that first described new methods of inquiry into the Natural Sciences. In this context, Bacon said that we can use "noble discoveries" that will come from the new method of inquiry to "renew and enlarge the power of the human race itself over the Universe" (Kitchen, 1855:129). Bacon's thesis became the foundation of the subsequent work by René Descartes (1637). In this regard Descartes noted that "[I] saw that one may reach conclusions of great usefulness in life, an[d] discover a practical philosophy [i.e., the Natural Sciences] … which would show us the energy and action of fire, air, and stars, the heavens, and all other bodies in our environment and [we] could apply them … and thus make ourselves masters an[d] owners of nature" (emphasis added) (Anscombe & Geach, 1954:46).

From these early philosophical origins, so-called scientific methods became the foundation for the construction of knowledge. These methods were based on experimentation, which sought to establish direct linkages between cause and effect, and as such were based on the principle of reductionism. Central to this early scientific discourse was the desire to become "masters and owners of nature". This seemed to be the logical way to proceed for the philosophers of science at that period in time, because it fitted in neatly with Christian biblical notions of Man being created in the image of God, having been placed on Earth in a position of natural dominance over all other animate and inanimate objects. At the time of these early writings, nature was a source of fear and trepidation with natural disasters such as floods, famines, avalanche and disease being the order of the day. Consequently the pursuit of scientific knowledge, and in particular knowledge that would give Man some respite from the ravages of Nature, were particularly valuable and consequently considered to be noble.

The modern day Natural Sciences are firmly embedded in this philosophical reasoning. This is strongly evident in hydraulic engineering for example, where the Hydraulic Missions of specific states are reflective of the desire to correct what were perceived to be the perturbations of nature. An example of this is found in the USA. Roosevelt approved the Land Reclamation Act on 17 June 1902, which in turn gave rise to the 'Bureau for Reclamation'. The very name of the institutional entity reflects an inherent assumption about Man and Nature. This was made evident in a speech prior to the acceptance of this legislation in which Roosevelt said, "the western half of the United States would sustain a population greater than that of the whole country today if the waters that now run to waste were saved and used for irrigation" (emphasis added) (Reisner, 1993:112). This American Hydraulic Mission was consequently based on the notions of river water 'conservation' through the action of damming and piping it in order to 'make the desert bloom'. In deconstructed form, this hydraulic mission sought to assert Man's control over Nature, by redirecting the fresh water flowing in rivers, in order that the dry lands could be reclaimed from Nature. In deconstructed form, Nature was seen as being wrong in allowing fresh water to flow 'to waste' into the sea and for deserts to exist where humans wanted to settle. As such the Hydraulic Mission was constructed as being a noble pursuit, fitting perfectly with the Descartean notions of being masters and owners of Nature. As a result, the "engineers who staffed the Reclamation Service tended to view themselves as a Godlike class performing hydraulic miracles for grateful simpletons who were content to sit in the desert and raise fruit" (Reisner, 1993:114).

Similar examples exist in Spain, where Swyngedouw (1999a; 1999b) has shown the existence of a powerful urge to show mastery over Nature, in this case as a partial response to the shock of losing the Spanish Empire. This is referred to by Swyngedouw (1999a) as "the production of nature" in which the Hydraulic Mission seeks to correct perturbations by means of creating a hybrid between Man and Nature. In this regard he notes that "hydraulic politics, understood in a broad and symbolic sense as a process of transformation of agriculture from extensive into modern and intense [forms] must constitute the fundamental vector of [Spanish] national politics. This must catalyze an agrarian reform which would permit a balanced economic development …" (Swyngedouw, 1999a). As in America, the Spanish Engineering Corps, which was founded in 1799, is still "highly elitist, intellectualist, 'high cultured', male dominated [and] socially homogenous" playing a major role in Spanish politics and development discourse (Swyngedouw, 1999a).

Current research that is being conducted by a team at the African Water Issues Research Unit (AWIRU) has found that a similar pattern is evident in South Africa. In this case, the South African Hydraulic Mission was based on the desire to control Nature as a means of managing risk in an uncertain social, ecological and political setting. The South African hydraulic engineers have also been trained in Descartean methods, and show similar attributes to those found in Spain and the USA, although this is undergoing a rapid change at present.

In essence therefore, what started with Galileo, being developed further by Descartes, Spinoza and culminating with Newton's grand synthesis in the late 17th Century, was the development of a powerful and enduring paradigm. This new view emphasized the simplicity of Nature because of its reductionist logic, opening the way to the interpretation of natural phenomena by mathematical law, and more fundamentally, the machinelike character of the natural world (Homer-Dixon, 2000:108). To Descartes, "he made of [N]ature a machine and nothing but a machine; purpose and spiritual significance had alike been banished" (Randall, 1940:241, in Homer-Dixon, 2000:108).

Consequently, what can be concluded from this is the fact that Descartean philosophical foundations are strongly evident in the Natural Sciences today, and still impact on the way that we construct knowledge, which in turn impacts on the way that we interpret information. This has urged social theorists like Giddens (1984:335) to conclude that there are social barriers to the reception of scientific ideas and provable truths. Yet it is also true that we have fallen prey to the seductive powers of our modern technological achievements, and many of us have come to believe that a reality outside of our constructed world is unimportant, because if we ever have to, we can manage any problem that may arise there (Homer-Dixon, 2000:83). It will consequently be argued in the rest of this paper that this is clearly evident in the climate change discourse.

**Man and Nature**

What we have established thus far is that knowledge is constructed, using a set of conceptual tools. Inherent within each of these concepts is a set of implicit assumptions that are only evident once we try to actively deconstruct them. In order to explore this further, we can look at the evolution of models of nature, sensitive at all times to the way in which they have been constructed. An excellent indicator of this is the relationship between humans and natural ecosystems.

Holling (1994a, in Homer Dixon, 2000:131) makes a key distinction in the epistemology of natural systems and the way we have developed simple mental models of how those systems work. Our epistemology is distinct from, but related to, the simple mental models that we have constructed of Nature. In this regard, Holling distinguishes two dominant epistemologies, which for argument sake, are illustrated in the field of Biology.

* Molecular biology is a science of parts. As such it is reductionist in its logic, stressing the need for careful analysis, meticulous data collection, precise statements and the rigorous testing of theories. Therefore it is essentially experimental and narrow in focus with a special interest in understanding the properties of the smallest building blocks that can be isolated.
* Evolutionary biology and ecology is a science of the integration of parts. As such it builds on the products of other branches of science, but is intrinsically less interested in the properties of individual component parts than in what emergent properties can be identified when these parts are combined into a larger whole. Therefore it is essentially pluralistic (being interdisciplinary in its configuration), and more accepting of uncertainty and surprise.

Building on this, Holling (1994b, in Homer-Dixon, 2000:131-133) concludes that there are four distinct models of Nature, each marking the chronological stages in the development of ecological knowledge. These are as follows:

* Nature Balanced prevailed in the early 20th Century. This was based on notions of stable equilibrium and balance between self-regulating populations and their environmental support systems. This was based on mathematical-like understanding of the mechanistic functioning of Nature and was often found as the fundamental rationale of governments and large corporations. Language constructs included notions of equilibrium, balance, climax and maximum sustainable yields. It is this construction of knowledge that Sullivan (2000) found to be the basis of colonial-era land management bureaucracies in Namibia.
* Nature Anarchic grew as a response to the earlier discourse on the environment (Nature Balanced). This view held that organisms within ecosystems are highly diverse and do not maintain a self-regulating balance among themselves. Ecological stimuli originate in the form of pressure from outside of the ecosystems themselves, such as the migration of animals, the population of new plant species and changes in the climate. These in turn cause wide fluctuations in the complex pattern of interactions between the various organisms living in the given ecosystem. Over time however, the concept of anarchy began to suggest disorder, whereas Nature clearly seemed to manifest a high degree of orderliness, so the model seemed to be flawed.
* Nature Resilient thus began to emerge as the new paradigm. In this model, ecosystems are seen as being highly resilient if the relationships between the respective organisms persist in the face of sharp shocks from outside of those systems. In this regard, Holling (1973, in Homer-Dixon, 2000:133) makes a key distinction between resilience and stability. Resilience determines the persistence of relationships within a given system in the face of unexpected external pressures, whereas stability is the ability of a system to return to an equilibrium state after a temporary disturbance. Within this model, complex ecosystems are understood to consist of a plethora of nested sub-systems. Nested systems in turn range from the macro to the micro level and are structured around a range of features such as keystone species, periodic extreme events and long-term carbon, nitrogen and sulfur cycles. Inherent within this model are notions of complexity, uncertainty, nonlinearity and change in which multiple stable states are the rule rather than the exception.
* Nature Evolving is the latest paradigm in ecological thought. While this does not deny the existence of ecosystem resilience, it does suggest that we have entered into a new era, marked by a dialectical evolution of Man and Nature. This is strongly evident in Swyngedouw's (1999a; 1999b) analyses. In this model, Holling (1994a, in Homer-Dixon, 2000:133) notes that anthropogenic impacts are now so large that they are changing our ecosystems to such an extent that the underlying processes are being compromised. Manifestations of these altered ecosystems, such as collapsed fisheries and global warming, force us to change our behavior in what Giddens (1990) calls reflexivity - concern with the undesirable consequences of our actions and the desire to do something about it. Holling (1994a, in Homer-Dixon,

2000:133) therefore concludes that "not only is the science incomplete, [but] the system itself is a moving target".

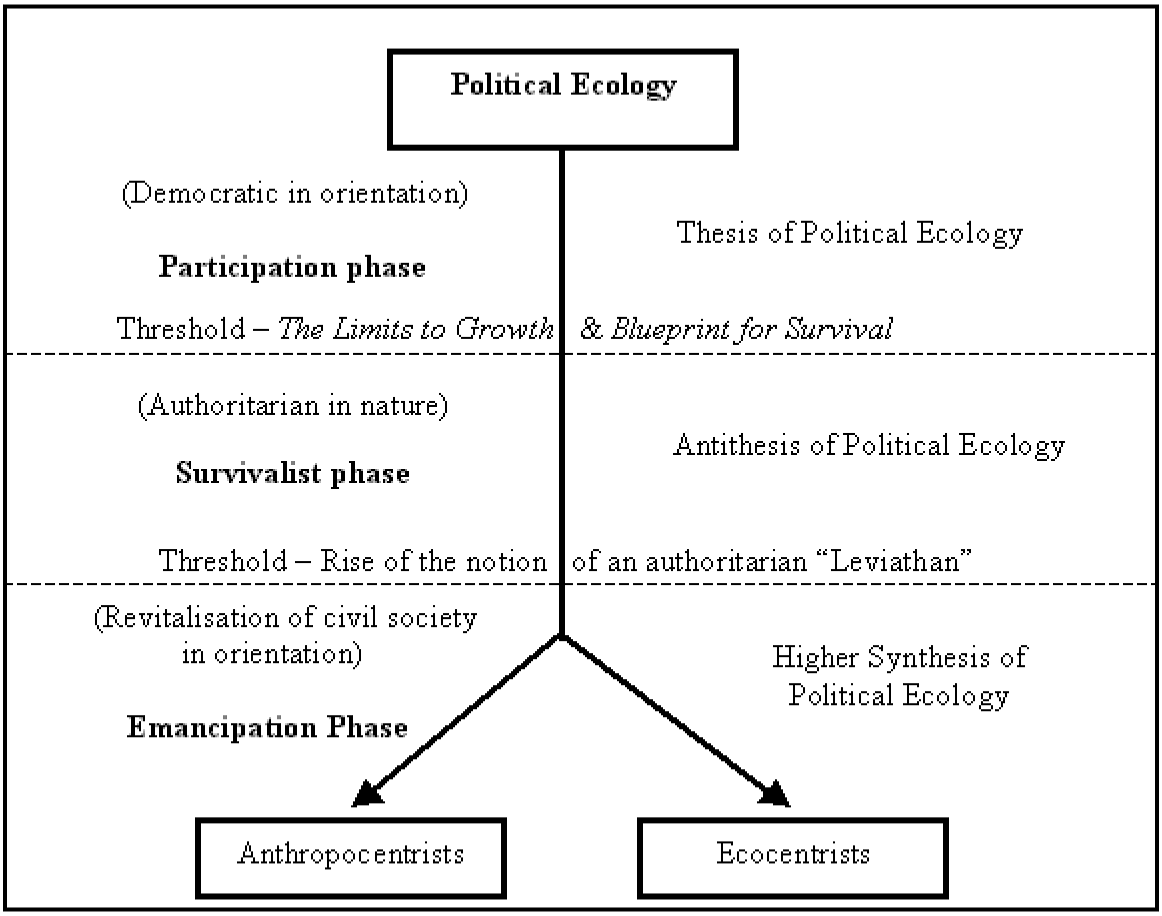



**Figure 1. Schematic representation of the various phases in the development of political ecology philosophy showing the currently prevailing two schools of thought (Turton, 2000a:134).**

What we see emerging is a change in paradigms about ecological thinking over time, but central to all is an assumption about Man and Nature. Initially Man is seen as being the master of Nature, whereas current thinking sees some form of hybrid emerging between Nature and Man in the form of technology, with the contemporary debate reflecting who or what should be in the middle - Man or Nature. This is also evident in the Emancipation Phase of political ecology thinking as shown in Figure 1.

Inherent within this paradigmatic evolution is the notion of complexity, and in particular, a movement away from a model based on mechanistic simplicity and predictability, towards a model based on risk, uncertainty, nonlinearity and consequently unpredictability. Implicit in this is a dialectic of Man and Nature, with works such as Stone's (1974) classic being examples of an emerging desire to place humans back into the ecosystem above which they seemed to have emerged as a new master. In this regard, Homer-Dixon (2000:167) concludes that as markets and social systems get more complex, the requirement for management ingenuity rises concomitantly. The same can be said of 'ecosystem management' that is implicit in Holling's model of Nature Evolving. We will return to this later on in the paper.

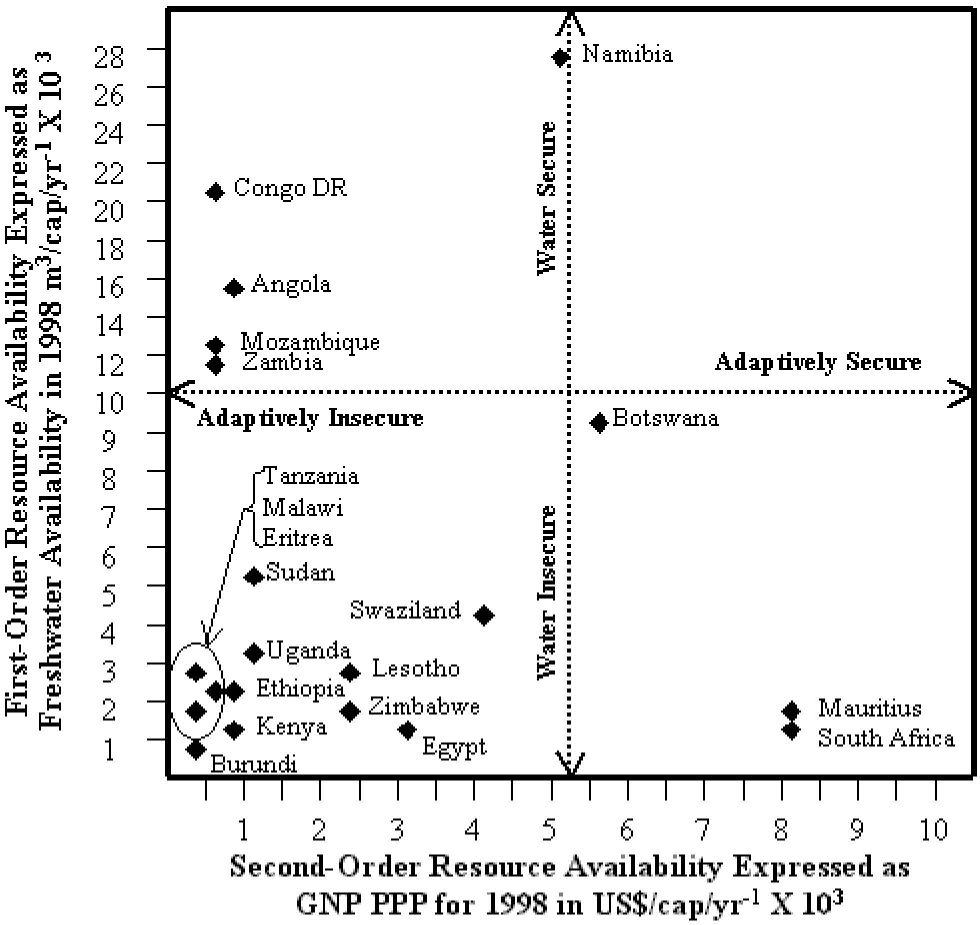
Towards a Political Ecology Discourse of Climate Change: 1st and 2nd Resources

In order to develop a political ecology discourse of climate change, it is necessary to dwell for a moment on the way we construct our knowledge about what constitutes a resource. An important conceptual and epistemological distinction has been made by Ohlsson (1998; 1999) between what has now come to be known as a 1st and a 2nd Order Resource. In this regard, a 1st Order Resource is any natural resource such as water, land, minerals etc., with which a country may be either well endowed or poorly blessed. Consequently, a 1st Order Resource such as water may be either scarce or abundant, with the degree of scarcity and/or abundance being relative spatially, temporally and in terms of quality. Under conditions of global climate change, the conventional discourse focuses on this aspect alone.

A 2nd Order Resource, on the other hand, is a social resource. It is the need, acutely perceived by societies, administrative organizations and managers responsible for dealing with natural resources of a country, to find the appropriate societal tools for dealing with changes in the 1st Order Resource availability (Ohlsson, 1999:161). In other words, what is critically important in terms of this conceptual split, is not so much the availability of the natural resource itself (1st Order level of analysis), but rather how society adapts to changes in that supply (2nd Order level of analysis), either by way of long-term increases in water scarcity or abundance as a result of climate change, or shortterm changes in the form of floods or droughts (Turton & Warner, 2001). In terms of this thinking, the management of natural resources such as water, is depicted as being a series of oscillations between 1st Order and 2nd Order Resources over time, much like the turning of a screw (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000), in which priorities change from supply-sided management (mobilizing more water) through demand-sided management (doing better things with available water) ultimately to adaptive management (adapting to absolute scarcity).

If this argument is valid, then it places a new emphasis on the climate change debate, and allows us to construct our knowledge in a slightly different form. Ohlsson's 2nd Order Resource is simply another way of looking at what Homer-Dixon (1995; 1996; 2000) refers to as 'Ingenuity'. As such this has particular relevance for understanding the problems confronting developing countries (Turton & Warner, 2001).

From this conceptual differentiation, the author started to develop a set of new concepts specific to the management of water resources. This was achieved by means of a matrix showing different levels of 1st and 2nd Order Resources expressed as two extremes of either abundance or scarcity (Turton & Ohlsson, 1999). A variation of this matrix is presented in Figure 2.




Data Source: World Bank Atlas, 2000.

**Figure 2. Variation of the Turton/Ohlsson Grid for Selected African Countries (Turton & Warner, 2001).**

The matrix presented in Figure 2 shows 1st Order Resources on the vertical axis, expressed as freshwater availability per capita in 1998, with 2nd Order Resources being shown on the horizontal axis, expressed as GNP per capita in US Dollars adjusted to purchasing power parity for 1998. Two arbitrarily defined thresholds have been superimposed onto the grid, in order to make a crude distinction between high and low availability. From this it is evident that 2nd Order Resources are the determining factor when it comes to converting natural resources into economic activity or political stability. Countries in the lower right-hand quadrant are mostly 1st Order Resource poor, but due to their ability to mobilize sufficient 2nd Order Resources, seem to be able to still generate economic growth and relative political stability.

If this hypothesis is correct then it casts a new light onto our understanding of what a resource is, particularly in terms of the climate change debate. Here we link up again with what was noted earlier in this paper - that as markets and social systems get more complex, the requirement for management Ingenuity rises concomitantly (Homer-Dixon 2000:167). In order to find a suitable answer to this problem, we turn our attention to the work being done by Thomas

Homer-Dixon.

Homer-Dixon (1995; 2000:21-26) develops his argument around the concept of Ingenuity, which as previously noted, is merely another manifestation of Ohlsson's (1998; 1999) concept of Social Adaptive Capacity. In this regard, Ingenuity is defined as ideas that can be applied to solve practical technical and social problems, such as the problems arising from water pollution, cropland erosion (Homer-Dixon, 2000:21) and the impacts of climate change. Seen in this light, Ingenuity can be described as consisting of sets of instructions that tell us how to arrange the constituent parts of our social and physical worlds in ways that help us to achieve our goals. As such, it is totally compatible with the methodological approach used in this paper - political ecology - because it has as a core theme, the manner in which we make sense out of an infinite array of mostly disconnected data or the construction of environmental knowledge.

Homer-Dixon (2000:22) goes on to note that the amount of Ingenuity needed to run systems, such as anthropogenically created urban environments (or what Swyngedouw (1999b) calls the production of socio-nature as a hybrid), is not the same as that needed to create those environments in the first place. In this regard, Homer-Dixon (2000) makes the distinction between two forms of Ingenuity:

* Technical Ingenuity is what is needed to create new technologies. As such it enables us to solve problems in the physical world.
* Social Ingenuity is what is needed to reform old institutions and social arrangements. As such it helps us to meet the challenges we face in our social world, often as the result of things happening in the physical world.

Homer-Dixon (2000:22-3) has come to realize that Social Ingenuity is a critical pre-requisite to the development of Technical Ingenuity. For example, we need Social Ingenuity to design functioning markets capable of responding to the needs of society, and we need market incentives to produce an adequate flow of technologies. A product of a functioning social system is the negotiation of political coalitions in order to construct various institutional arrangements; competent bureaucrats plan and implement the necessary public policy, and ordinary people living in various communities build local institutions and adapt their behavior in order to solve the various problems that they face.

After substantial research on the subject, Homer-Dixon (1999; 2000:23) has concluded that the Ingenuity requirement increases rapidly as environmental problems worsen, because societies need more sophisticated technologies and institutions in order to solve those problems. The benchmark in this case was defined as the amount of Ingenuity needed to compensate for any aggregate social disutility caused by environmental stress - in other words - the minimum amount of Ingenuity that a society needs to maintain its current aggregate level of satisfaction despite the stress caused by environmental scarcity (Homer-Dixon, 1999:111). Consequently, the supply of Ingenuity within any given society involves both the generation of good ideas and their implementation within that society. As such, many of the obstacles seemed to occur not when the Ingenuity was originally generated, but rather when people try to implement those ideas, with the biggest obstacle being political competition among powerful groups, which often results in the failure of key institutional reforms (Homer-Dixon, 1995; 2000:23). This has led Homer-Dixon (2000:23-4) to conclude that societies experiencing severe Ingenuity gaps - that condition where the supply of appropriate Ingenuity falls short of the demand for that specific Ingenuity - cannot adapt to or mitigate environmental stress. This notion is similar to what Turton & Ohlsson (1999) have called Social Adaptive Capacity, and what Ohlsson & Turton (1999) have identified as being bottlenecks in resource management.

Seen in this light, the countries in the upper left-hand quadrant of Figure 2 are confronted with a classic problem. The scarcity of 2nd Order Resources prevents the development of the Social and Technical Ingenuity needed to develop. It therefore comes as no surprise that some of the countries listed there - Angola, Democratic Republic of Congo and Mozambique - have been ravaged by decades of civil war and are consequently nothing more than quasi states today. The countries in the lower left-hand quadrant of Figure 2 face an even more daunting task, because in this case they are confronted by a scarcity of both 1st and 2nd Order Resources. These are what Turton & Ohlsson (1999) and Turton & Warner (2001) have defined as being under conditions of 'water poverty'. Conversely, the countries in the lower right-hand quadrant of Figure 2, are the most economically developed in their specific regional settings, simply because they are apparently capable of mobilizing sufficient Social and Technical Ingenuity. One specific case in this category - South Africa - is very illuminating. Whereas all evidence seemed to be pointing towards a vicious civil war based on race, an extraordinary amount of Social Ingenuity was mobilized in the late 1990s. This led to complex negotiations that ended Apartheid, creating new political institutions, thereby paving the way for a relatively peaceful transition to democracy. It seems therefore that 2nd Order Resources are the critical issues to focus on in the context of developing countries, particularly in the field of natural resource management and global climate change.

## Reconstructing the Climate Change Discourse from a Political Ecology Perspective

Having noted the importance of 2nd Order Resources, it now becomes instructive to try and reconstruct the discourse on Man and Nature, specifically in the context of the climate change debate. As noted above, Ingenuity plays a crucial role. Central to this is human intelligence, so it becomes instructive to understand how this has developed over time. Homer-Dixon (2000:195) cites Calvin (1996) in this regard. Working on issues such as climate change, Calvin has developed a cluster of features that define human intelligence. These include imagination, the use of symbols and

language, the capacity to engage in complex planning and a broad base of knowledge from which to draw solutions. Central to this is the human ability to adapt to unexpected circumstances. Calvin (1996:12) notes that "the best indicators of intelligence may be found in … those rare or novel situations for which evolution has not provided a standard response, so that the animal has to improvise, using its intellectual wherewithal". Calvin (1996:117) goes on to say that intelligence "implies flexibility and creativity - in the words of the ethnologists James and Carol Gould (1994:68-70), an 'ability to slip the bonds of instinct and generate novel solutions to problems'".
It seems therefore, that problem solving is central to the development of animal intelligence. This being the case, it becomes instructive to review some key evolutionary theory in order to explain how intellectual powers developed.

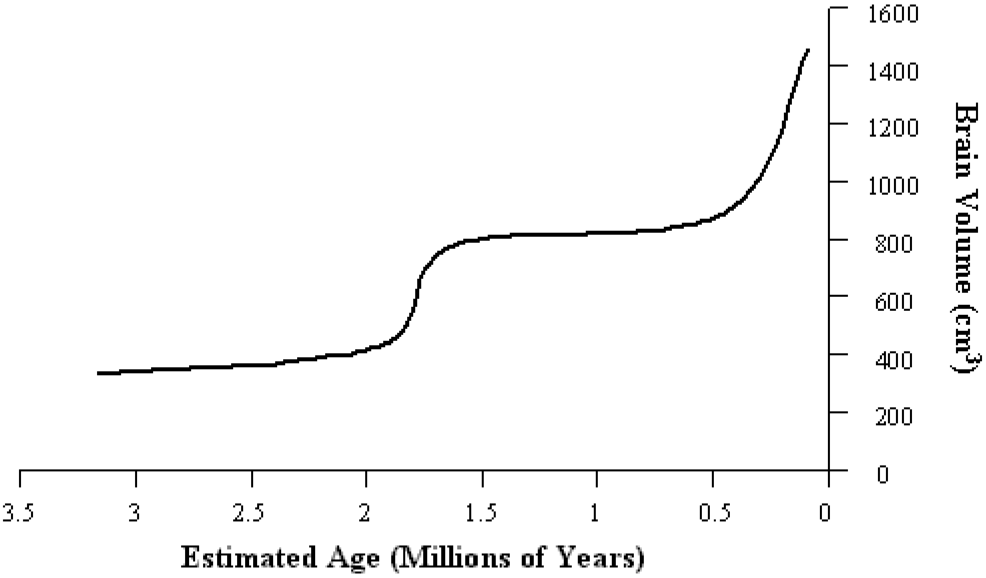



**Figure 3. Hominid Brain Volume has Expanded in Two Bursts. Adapted from Homer-Dixon (2000:197).**

Charles Darwin proposed the Savannah Hypothesis in order to explain how evolutionary pressure was responsible for developing intellectual powers. In terms of this hypothesis, the African forests were thought to be shrinking in response to climate cooling at around the beginning of the Pleistocene (Homer-Dixon, 2000:197). As the Savannah expanded, the level of uncertainty facing early hominids increased, but with greater uncertainty came increased opportunities as well. Faced with this greater challenge, the hominid brain started to develop in complexity, as evidenced by the volume of various skulls. From an analysis of the skull volume, an interesting manifestation is evident. Figure 3 shows one possible interpretation of aggregate data plotting brain volume as a function of time (Homer-Dixon, 2000:197). From these data two distinct periods of brain development can be detected. The Savannah Hypothesis can be used to explain the first rapid increase in hominid brain volume, but not the second.
Recent work by paleoanthropologist Rick Potts (1997) has challenged theories of hominid brain development that are based on the underlying assumption of climatic stability. Instead, Potts (1997:168 in Homer-Dixon, 2000:198-9) has suggested that the environmental conditions in which hominids evolved was highly unstable. Studies of fossilized pollens, sediment layers and other indicators suggests that the mid to late Pleistocene (700,000 to 100,000 years ago) was also a period of extreme climatic variability. These variations were so dramatic in fact, that they were the most extreme since the time of the dinosaurs, some 64 million years before (Potts, 1997, in Homer-Dixon, 2000:199).
In response to extreme climatic fluctuations, living organisms can essentially respond in two different ways (Homer-Dixon, 2000:199). They can retain their specialist lifestyles by migrating to areas that favour this particular form of adaptation, or they can stay in the same general location by developing a more generalist approach to survival. Such an approach seemed to have been chosen by hominids, and this in turn raised a new set of challenges. For example, it now became necessary to live in larger social groups in order to survive. This in turn meant that social skills were needed. Memory started to play an important role, specifically with respect to developing mental maps of the local environmental conditions. This is evident today in large mammals such as the African Elephant, and in particular those living in highly variable conditions such as those occuring in the Namib Desert. These elephants can remember important details about the location of water, and are known to move through the desert to specific locations that were favorable to survival under extreme conditions decades earlier. Similar strategies in hominid groups would have improved chances for survival under conditions of rapid climatic variability. Language would also help to coordinate a group of hunters, and in particular to pass on valuable information such as the existence of safe refugia in times of need. Yaneer Bar-Yam (1992:808, in Homer-Dixon, 2000:200) concurs that the hominid brain developed a level of complexity in direct relationship with the levels of environmental complexity confronting that brain. Potts (1997:244,

in Homer-Dixon, 2000:200) has concluded that greater cognitive capacity and behavioral versatility grew into symbolic coding, the development of complex social institutions, cultural diversity, technological innovation, outward migration to new and as yet unoccupied parts of the planet as a colonizing species, greater self-awareness and a tendency to buffer harsh climatic variations by altering the immediate surroundings by hominids.

Recent work has shown that hominids evolved four specialized capabilities (Mithen, 1996, in Homer-Dixon, 2000:202):

* Technical intelligence in order to understand things such as gravity and inertia, and in particular how to use these to hunt large animals in the most effective way possible.
* Natural history intelligence in order to identity and categorize plants and animals and to understand the relevance of these to daily survival.
* Social intelligence in order to develop complex social arrangements, social institutions and to retain the necessary social cohesion on which survival depended. This implies the development of rules and the mitigation of conflict in order to maintain some degree of social harmony.
* Linguistic intelligence in order to use abstract symbols to describe the natural and social world. This also implies the ability to transmit knowledge from one generation to another, greatly increasing chances for survival under conditions of uncertainty or climatic variability.

A specific element in the evolution of mental development is the capacity for analogy and metaphor. The ability to see similarities among a diverse range of objects and events, coupled with the ability to combine ideas that emerge from these different forms of intelligence are essential elements of human creativity (Homer-Dixon, 2000:202). The archeological record shows a veritable proliferation in art, ritual and complex tool making around 600,000 years ago, providing the first solid evidence that the four different types of intelligence were starting to interact in the hominid brain at that time (Mithen, 1996:209, in Homer-Dixon, 2000:203). It is through this expression of abstract ideas that human Ingenuity started to develop, with the transmission of ideas as sets of instructions (about how to manage under conditions of environmental variability) from one generation to the next becoming a key to survival. Culture, when viewed from this perspective, is like a pipeline carrying knowledge from our past into our future (Homer-Dixon, 2000:205). Consequently, for scientists like Potts (1997:277) the message from the Pleistocene is one of optimism, saying that "the strange buoyancy of the hominids is in us, a hopeful heritage of response to novel environmental dilemmas" (Homer-Dixon, 2000:277).

From this two conclusions can be drawn:

* Climate change is responsible for the development of the human race into the dominant species it is today, particularly with respect to intelligence.
* Early human development emerged from Africa.

Yet both of these are somehow contested in the modern world. In the first instance, the construction of knowledge in the current climate change debate is being framed in such a way as to suggest that variability is a threat to humanity. In the second instance, Africa's contribution to the world is either downplayed, and in some historic cases, was actively countered (although this is starting to change). The best example of this can be found in the saga of the Piltdown Man. Paleoanthropological work that was being conducted in the early part of the 20th Century, suggested that large volume brain cavities emerged in Europe. Evidence for this was provided in the form of a skull and partial jaw of what became known as the Piltdown Man. As Harter (1997) notes, "he [Piltdown Man] was the expected 'missing link' … [and] best of all, he was British!" Raymond Dart was sent to South Africa from London in order to start working on the paleoanthropological history of Southern Africa. In 1924 Dart found a skull fragment of what became known as Taung Man (Australopithecus) in a location close to the home of the author. Dart submitted this as evidence of early hominid development in Africa to Sir Arthur Keith at the University College of London (UCL), but this evidence was shunned. Dart continued to work, but in relative isolation and facing some degree of ridicule from the mainstream paleoanthropological community, largely as the result of Keith's writing (Tobias, 1992). Dart retained his initial views on Taung Man, and after a number of years of isolated work, was supported by Robert Broom and William Gregory, both of whom were highly respected scientists. This team started to piece together their evidence in a meticulous fashion, ultimately resulting in a startling discovery. Piltdown Man was a fraud (Weiner, 1955; 1980) and nothing more than a construction of knowledge that was cleverly crafted to suit the cultural Darwinistic views which were dominant in England during that period of history. In terms of this view, intelligent hominids simply had to have emerged in Europe rather than in Africa, a view that was heavily influenced by Darwin's 1859 Classic, Origin of Species. Taken to its logical conclusion, if species evolved through a process of natural selection as Darwin had hypothesized, then clearly that selection would have favoured the 'high civilization' found in Europe, and in particular that embodied in the form of an Englishman. This is the foundation of much of the colonial experience in Africa, manifesting in various bureaucracies such as those responsible for land management and so-called 'native affairs'. It is also the genesis of natural suspicion about the motives of the former Colonial masters in particular, and the North in general.

**The Challenges of Climate Change**

Climate change should consequently not be seen as a threat to humanity, but rather as a major challenge, and the way that we construct our knowledge should reflect this. The challenges are many, and the highly complex web of interactions that have been caused by the successful colonization of virtually every ecosystem on this planet by humans, will tax our combined wisdom to the extreme. Yet the message is one of hope.

This paper has sought to present an alternative view on some of the issues relating to climate change. In particular, it has sought to highlight two key issues. Firstly, the way that we construct our knowledge contains within it implicit assumptions and power relations. Secondly, the way that we define a resource is important. So let us deal with the latter first. This paper has shown that climatic variability is the norm rather than the exception, and that this variability has been central to the development of human Ingenuity, of which two distinct types exist. We will need massive Social Ingenuity in order to negotiate agreements between countries, across language and cultural divides, and more importantly, across the North/South rift. As things currently stand, the negotiations around the United Nations Framework Convention on Climate Change (UNFCCC) are being dominated by the developed North, with the developing South being somewhat isolated and marginalized in the process. In particular, large powers like the USA are reneging on past agreements (Financial Times, 2001:6). This will stall existing negotiations and will undermine the development of political will and institutional arrangements with which to effectively attack the problem. At present the majority of this Social Ingenuity is coming from the North, with growing suspicion in the South. But we will also need much more Technical Ingenuity than we currently have available, even in the highly developed North. The 'brain-drain' from the non-industrial South is also an important factor to consider, decreasing the capacity of developing countries to respond to the new demands of a globalized and changing world. For example, Africa lost 60,000 middle and senior managers between 1985 and 1990, whereas in India 30% of the graduates from the Indian Institute of Technology emigrated between 1970 and 1990 (Homer-Dixon, 2000:260). The state of the art is also lacking, with scientists often being unable to reach agreements on key methodologies or issues. This again points back to Social Ingenuity. And where are the scientists from the South? Unfortunately they are conspicuous by their absence. Central to this argument - and this is a key objective of this paper - is to change our ideas about what we view as a resource. It is the contention of the author that 2nd Order Resources are going to become the key element in the long-run. How do we understand these resources at present? In truth, we are in the dark about them. We do not even have adequate definitions of what they are and we have only the crudest of indicators at our disposal with which to develop models and theories. So clearly we are confronted with a major challenge in this regard. This is a challenge that needs to be responded to not only by the Social Sciences, but also by the Natural Sciences. We need to develop language registers capable of communicating across disciplines (and not only by the industrialized North), and we need to develop methodologies that are capable of accommodating the vagaries of different approaches. This is a huge challenge indeed, and one that falls squarely within the parameters of what we now understand to be Social Ingenuity.

Returning now to the first issue - the way we construct our knowledge - we can answer the questions posed at the start of this paper.

* Who currently holds power over influential narratives?

In the case of the climate change debate, the narratives are firmly embedded in the Natural Sciences at present. This means that natural scientists set the agenda and maintain hegemony over the discourse by determining key epistemologies. The Social Sciences at present have only a limited impact on the climate change discourse.

* How is this power employed and for what political purposes?

The hegemonic control over the climate change debate has two key elements to it. Firstly, it is located mainly in the Natural Sciences. Secondly, these scientists are mostly based in developed countries of the North. As such there is a strong bias towards what may be described as Reflexive Modernity (to use Giddens' analogy) or Risk Society (to use Beck's analogy). As such the playing field is far from level. This is evident in the UNFCCC deliberations, and in particular with respect to the Clean Development Mechanism (CDM). Scientists and negotiators in the North are convinced that these are fair and reasonable, whereas their counterparts in the developing world are convinced that they are not. Stated simplistically, the developed North is constructing knowledge around a perceived risk that has at its heart, the notion of becoming reflexive about development in the North. While this sounds highly logical to a scientist from the North, it means that the skewed global development pattern will be frozen, with North/South inequalities being perpetuated. Notions of fairness, perceptions of reality and ideals associated with equity are at the heart of this issue, yet it is impossible to define these in concrete terms because they are inherently value-laden. The Natural Sciences can be of little help in such a debate.

* What is the science that supports these defined narratives?

This is an interesting question to answer, and the answer provided will no doubt be hotly contested. From a Southern perspective, the Northern-based science is in fact shaky to say the least. Major uncertainties exist about a number of key issues. We cannot effectively model climates that result from a near infinite number of variables. Chaos theory shows us that even with three variables at work, the range of possible outcomes is so large as to become nearly meaningless. We do not fully understand the functioning of key physical manifestations such as the thermohaline circulation in the North Atlantic and the El Niño/La Niña oscillations in the Pacific, and we understand the triggers and drivers of these even less than we understand the connection between these fundamental natural processes.

Consequently it seems as if the science is not as solid as it should be, given the complexity of the problem it is trying to tackle. In other fields we see similar developments, where we cannot really predict things like the risks associated with Mad Cow Disease, the spread of Foot and Mouth Disease and the possible environmental implications of genetically modified organisms which current technology allows us to produce with relative ease. Science it seems, based as it is on reductionist logic, may not be up to the task at hand, and efforts at generating a more integrative approach are being hampered by our apparent inability to mobilize sufficient Social Ingenuity with which to gain consensus on key epistemologies. So again, we return to the importance of 2nd Order Resources, which we also know are severely limited in the developing South.
* What are the ideas of morality infusing these narratives and their supporting science?
Here again the answer is likely to be a contested one, in all probability reflecting the North/South dichotomy noted above. Inherent in the way that we have constructed our knowledge about climate change, and in particular in the way that we have constructed our understanding of the risks inherent to that change, is a strong North-based morality (if such a generalized thing can be said to exist). We have moved our perceptions of risk away from the rapidly expanding frontier mentality of conquering new natural resource bases as new technologies become available, or in response to depleting resource bases elsewhere, to a more global perception. This has been triggered, at least in part, by recent satellite images of the Earth, seen as a rather fragile ecosystem that supports the only known life forms in the entire Universe, floating as it were, in the infinite vastness of hostile space. This in turn has caused a change in morality and perspective. When critically examined, the industrialized North is emitting the majority of greenhouse gasses, and it is they who are saying that we are on an unsustainable path. So having voraciously consumed the worlds resources as a development strategy, they are now saying that development as we know it is unsustainable and must consequently be stopped, or at least slowed down. The developing South has been sensitized to the consumer society values of the developed North, and now aspires to those levels of 'development'. Unfortunately we do not have the technologies that the industrialized North have, so people in the South are saying that they cannot be denied the right to develop, and unfortunately the only model of development that seems to have endured, is that based on industrialization and consumerism. Consequently the very concept of 'sustainable development' is value laden and represents a construction of knowledge that contains within it, powerful normative values and political bias.

**Conclusion**

This paper has sought to show that the way in which we construct our knowledge contains a number of hidden assumptions. An example of such knowledge constructs was given in the form of Piltdown Man, where it was shown that this knowledge was based on strong assumptions of cultural Darwinism. The existing discourse on global climate change has also been used as an example, and it has been shown that the current construction of knowledge favors a perception of risk that seeks to protect human beings from climatic fluctuations as we have become divorced from the ecosystems in which we live. This is proof of the enduring nature of the Descartean philosophy of science that drives us to become "masters and controllers of Nature". This is a manifestation of the 'man at the risk of nature' construct noted earlier in this paper. Evidence has been presented which suggests that human Ingenuity has been stimulated directly as a result of climatic variation. An optimistic tone has been adopted, suggesting that encoded within human beings at the most basic of genetic levels, is the ability to adapt. The existing knowledge has been deconstructed and an alternative knowledge has been proposed. Even here it has been shown that human bias, in this case cultural Darwinism, has been found in our recent historic past. Finally, it has been suggested that the current discourse on climate change, as manifest in the UNFCCC deliberations and the CDM as an instrument of carbon trading, reflects an unfair playing field, at least as perceived by negotiators from the developing world. In conclusion therefore, the notion of human Ingenuity has been used as a central theme. Just as past climate change has stimulated human Ingenuity, the current debate on global climate change can have a similar effect too. Yet in order to tackle the problem effectively, we will need to mobilize massive amounts of Social Ingenuity - what has been called a 2nd Order Resource - illustrating the need to redefine what we mean by the concept of a 'resource'. Emerging evidence suggests that the defining resource in the field of natural resource management, particularly in the developing South, is the mobilization of sufficient 2nd Order Resources - Homer-Dixon's (2000) Social and Technical Ingenuity or Ohlsson's (1999) Social Adaptive Capacity - and it is hoped that this will become more widely acknowledged in the global climate change debate in the near future.
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