The Earth is Not Yet an Artifact

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In the previous article in this issue [1], Brad Allenby argues for a more active style of planetary management. He notes, "the biosphere itself, at levels from the genetic to the landscape, is increasingly a human product."

While the earth is undoubtedly being transformed by human action [2]-[4], the implications of the transformation for environmental management are in dispute. Allenby suggests that the scale of human impact makes it appropriate to treat all landscapes as human products, subject to active management aimed at goals we collectively define. I question Allenby's claim that "there are no 'natural' systems anymore" [1], and question the utility of engineering-based management methods as tools for planetary management. In contrast to Allenby, I suggest that we learn to control our environmental imprint before embarking on active planetary management.

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Allenby defines "Earth Systems Engineering and Management" (ESEM) as "the capacity to rationally engineer and manage human technology systems and related elements of natural systems in such a way as to provide the requisite functionality" [1]. The goal is active environmental management as opposed to minimization of environmental impact [5, p. 76]. In advocating ESEM, Allenby stresses the extent of human transformation of the environment, arguing, "the earth has become a human artifact" [1]. He implies that, if the world is an artifact, then it is naïve to try to maintain a landscape in its natural state, and naïve to practice stewardship [5, p. 84]. I argue that while one may accept that artificiality demands active management, one ought to reject the claim that the world is now artificial.

IS THERE ANY NATURE LEFT?

It is undeniable that the boundary between natural and human systems is fuzzy. Likewise, it is fair to characterize the world's landscapes as ranging from heavily to lightly managed, and to be wary of unreflective characterization of any landscape as wild. Yet the claim that the earth has become a human artifact seems far too strong. Most landscapes are in the middle ground, and the details of this middle ground matter in disputes about environmental management.

In arguing for the world's artificiality Allenby notes that some degree of human influence can be detected everywhere; for example, that trace metals mobilized by bronze age smelting can be detected in the Greenland icesheet. The argument that any trace of humanity makes a landscape unnatural assumes that true nature must be pristine; or, equivalently that there is a sharp dichotomy between nature and culture. Allenby rightly questions this dichotomy, yet his analysis proceeds by claiming that all is culture, that "there are no 'natural' systems anymore," that, "difficult as it is to accept — there is no natural history anymore:

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there is only human history" [1]. Allenby critiques McKibben's "anguished commentary" about *The End of Nature*, but the essence of the critique is merely that McKibben misread the date of nature's demise. Excepting the date, Allenby's argument that the ubiquity of human imprint makes the world artificial is very similar to McKibben's statement that "By changing the weather, we make every spot on the earth man-made and artificial" [6, p. 215].

Many landscapes bear no visible trace of humanity yet are nevertheless modified by human action. At the northern limit of trees in the central Canadian Northwest Territories, for example, one may travel for days and see no sign of humanity except satellites in the evening sky. Yet even here, human imprint is ubiquitous from the top of the food chain where the absence of Pleistocene megafauna such as mammoths is (arguably) due to human caused extinction [7] to the lowest trophic levels where primary productivity is (likely) changing due to fertilization by anthropogenic nitrogen and carbon dioxide. An absence of visible signs is thus an unreliable test for the absence of impact. How then should we assess human influence? Consider some more technical measures.

In contrast to visible signs, the presence of a detectable trace of human action seems a reassuringly scientific measure, yet it tells us little because it hangs on the question of detectability and thus on the detection technology employed. Suppose that some future technology could detect signs of early Eurasian agriculture in North American ice-cores at a date prior to the first human arrival in the Americas. Would we conclude that the Americas had ceased to be natural at that date? I think not. This measure of human influence is irrelevant to the arguments for the world's artificiality both because it depends on the detection technology, and, as discussed above, because it assumes a sharp dichotomy between nature and culture.

The disruption of biochemistry [8], [9] and biodiversity [10] provide quantitative measures of the degree of human imprint that are more relevant to debates about environmental management that concern Allenby. On a global scale it is clear that some — but not all — such measures suggest pervasive anthropogenic disruption. The nitrogen cycle and the extinction rate are cases for which the anthropogenic perturbation is as large or (for extinction rate) much larger than the natural background. Despite these global aggregates, there are many areas where human influence remains slight.

Landscapes have aesthetic values that are not captured in the technical measures outlined above. One such value rests on a landscape's history. Consider, for example, a project aimed at restoring an environment that has been destroyed, say the restoration of a prairie after strip-mining. Such an artificially created environment could be pristine by all the measures discussed above, yet we would likely value it less because of its very artificiality. There is a strong analogy with the values we ascribe to works of art. We value a fake painting less than an original. We would likely value a fake even less if its creation necessitated the destruction of the original, as is the case with a prairie restored after strip-mining. One may ascribe a similar value to landscapes, a value tied to their historic origin: "What is significant about wilderness is its causal continuity with the past" [11, p. 230].

Now reconsider the claim "there are no 'natural' systems anymore" in light of the measures of human impact outlined above. While the world in aggregate is heavily influenced by humanity, there nevertheless exist many landscapes in which human influence is light. Specifically, there are still many areas where there is essentially no visible human imprint; where the majority of species have evolved in situ, largely unaffected by human influence [12, p. 158]; where the biochemical perturbations are small; and finally, where there is historic continuity with a pre-human landscape. Illustrative examples of lightly influenced landscapes are found in the arctic and in the interior of tropical rainforests. Such landscapes exist, they have a value, and they are not artificial.

Why does the existence of lightly influenced landscapes matter? The heart of the ESEM prescription for environmental management is the goal of "providing the requisite functionality" [1]. The joint claim that there are no natural systems anymore and that environmental management should aim only at functionality denies much of the traditional justification for the preservation of nature. Since the 19th century, the politics of wilderness preservation have been driven, in part, by convictions about the intrinsic value of nature [13]. Allenby urges us to dismiss these romantic ideals, and replace them with functional measures of nature's utility and with rational environmental management. In part, Allenby's comments draw from so-called postmodern efforts to demonstrate that nature is a cultural construct, and often a physical product of human action [14]. Interestingly, this assault on the reality of nature has been used by advocates from across the political spectrum, ranging from the pro-development Wise Use Movement to People for the Ethical Treatment of Animals, to argue against the protection of natural ecosystems [12].

Allenby would have us justify the preservation of nature by assessing the functional values that it provides. While such utilitarian arguments are important, I doubt that they will prove sufficient. I suggest that natural landscapes have some form of intrinsic rights [15] or moral value [16], and that these values are not simply tradable in a management regime aimed at achieving "the requisite functionality."

Artificial World?

Would an expansion of human influence make the world artificial? Not necessarily. Artificiality is a much stronger claim than influence. Artificial systems involve human agency in a fundamental way. The distinction is clear when we study a system's behavior. For example, one may characterize engineering and the social sciences as "the sciences of the artificial" [17], and may distinguish them from the natural sciences by the kind of explanation that is sought. Natural science explains events as the results of simple laws acting without human intent, whereas engineering and the social sciences are concerned with design and with the consequences of human intentions.

Similarly, one would only call a landscape artificial if resolving central questions about its behavior demanded an understanding of human agency. What would an artificial world look like? We may one day arrive at a world where climate and weather are actively controlled, where new genetically engineered cultivars and new fauna are common in every landscape, where the human gene pool has entered a period of rapid divergence [18]. In such a world, attributes ranging from the global concentration of CO_2 to the local distribution of biota would be determined more by human decision-making than by nature. Even if ecosystems closely resembled their pre-industrial counterparts, one would ask not how they evolved but why they were put there. Such a world would justify the term artificial in that geochemistry would be a form of engineering rather than a science.

The conclusion that the world is now artificial arises in part from a failure to distinguish between deliberately engineered environments, such as gardens, and the landscapes that are marked by what Allenby calls the "unintended byproducts of human engineering." This description covers the many landscapes that bear the scars of our industrial system without playing an economically important role in that system. Pollution, however, is not engineering. Intent matters. Intent is central to our understanding of engineering [17]. To claim that:

> "Throughout history, humans have continually designed and engineered the carbon cycle. That is, of course, what agriculture is all about"

is to equate to affect with to design. On this reading of design, the following claim is justified: beavers design hydrological cycle, that is what dam building is all about. As another critic of Allenby puts it "This is not engineering, just making a mess [19, p. 17]." The distinction matters: If we are just making a mess, then minimizing our mess makes sense. But if we are engineering the world, then ESEM — management not minimization — makes sense.

Implications for Climate Policy

What would an ESEM climate policy look like? It would be systematic climate management aimed at providing "the requisite functionality." It would entail the engineering of climate, or at least of CO_2 concentration, so as to provide the required meteorological conditions as well as the required ecosystem services. Allenby makes it clear that ESEM would draw from a large toolkit, ranging from source abatement to geoengineering. In addition to controlling industrial CO_2 emissions, an ESEM climate policy might employ countervailing measures such as the use of ocean fertilization to enhance oceanic carbon sinks, or alteration of the effective solar flux (via the use of space-based solar shields) to offset the climatic effects of increased CO_2 [1], [5], [20].

ESEM would build on the best examples of modern-engineering project management and would incorporate features such as distributed decision making, rigorous performance measurement, and extensive dialog with stakeholders. All these are fine features of project management once a project's overall goal is reasonably well defined. Yet for the climate problem the choice of goals is the crux of debate. Put most simply, what should the CO_2 concentration target be? Any choice has weighty consequences. There are winners and losers in any climate scenario, and trade-offs both between people and between people and natural systems.

Climate policy is now a contentious subject of international politics. While climate policy could use some improvement, it is unclear how ESEM would help. Allenby's ESEM includes a coherent vision of management process, but it is much less clear about goals and governance. The tools that Allenby draws on (e.g., industrial ecology and life cycle analysis) are intended to evaluate the environmental consequences of policy choices, but these tools have very little to say about the formation of environmental values and the resolution of conflicts between them [21]. Yet ESEM is essentially a proposal for planetary governance built from a project-engineering mold.

An ESEM climate policy is doubly challenging because Allenby makes clear that climate policy ought to be unmoored from its pre-industrial reference. The goal of ESEM is to find the climate that best enhances "functionality" rather than to minimize impacts so as to return us to the pre-industrial climate. Allenby presents two arguments for this unmooring. First, the artificiality argument: we have already messed with the climate; thus, the climate is an artifact; thus, the goal of climate policy should be management not minimization. Second, an argument in the language of postmodern analysis:

"A critical point implicit in many of the global environmental discourses is whether it is ethical to privilege the present. Thus, for example, the global climate change negotiations seek to stabilize current climatic conditions …[and] thus seek to remove an important driver of biological evolution" [1].

The second argument depends on an odd conflation of timescales. Climatic fluctuations, such as the glacial cycles that drive biological evolution, have time scales that exceed 10 000 years; concern about removing these fluctuations seems irrelevant given the overwhelming biological impact arising from the much more rapid human transformation of the planet. Before we concern ourselves with managing the planet on the glacial timescale, we need to learn to mitigate the immediate impacts of our industrial system.

ESEM is a radical prescription for climate policy. It suggests that we cast off our ties to pre-industrial climate and embark on a broad program of planetary engineering aimed at managing (improving?) the functionality of tightly coupled biogeochemical systems. One may accept that the world may become an artifact in the strong sense defined above; further, one may accept that wise management in such a world might bear some resemblance to ESEM, that, "not minimization but management" would be a fine maxim. But we do not yet live in such a world. Allenby urges us to punt the problem of learning to mitigate industrial emissions of CO_2 and move directly to a regime of global planetary management in which the mitigation of industrial emissions is just one of many tools. I disagree. We would be wise to learn to walk before we try to run, to learn to mitigate before we try to manage.

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