

# Our responsibilities for managing the Earth system

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**Summary:** *A change of mindset is needed in our management of the Earth system*

## 1. Introduction

The classic paper by Donella Meadows<sup>1</sup> identified twelve leverage points for intervention in complex systems, and concluded that effective intervention required a change of paradigm or mind-set. Human society needs such a change of collective mind-set in relation to the earth system, because it is on an unsustainable path in a world of limited resources. I am sure you are all familiar in broad outline with where we are and how we got there. The discovery of fossil fuels gave us (briefly in geological time) vastly increased energy supplies and wealth, and this has led to both a rapid growth in the human population and in the human consumption of natural resources. The industrial world quickly developed a very human-centered mind-set based on economic and consumer growth; while medical and scientific advances and fossil-fuel based agriculture led to rapid population growth. We quickly lost our social appreciation for the Earth's ecosystem of which we are a dependent part; and failed to foresee the impact on the stability of the Earth system of the rapid growth of the waste products of our industrial society. In efforts to maximize growth, without an explicit set of rules for managing the earth system, we have crossed or are about to cross many critical thresholds for the earth system<sup>2</sup>. It is challenging to estimate the carrying capacity of the planet<sup>3</sup>, but some have argued that given our growing population and consumption (and global inequity), the Earth's carrying capacity has already passed.

So we are faced with this reality. We are dependent on the Earth system, but our human impact has become unsustainably large. I propose that humanity change direction and base planning and decisions on Earth system reasoning, rather than traditional economic and political arguments. This requires that we deepen our collective understanding of the processes within the Earth system, which are dominated by the Earth's water cycle and its intimate connections to life, as well as the global and regional energy budget. At the same time we must accept our collective responsibility for the future of the Earth, while recognizing that much of the natural Earth system is beyond our control.

In a society where responsibilities have traditionally been compartmentalized, this is formidable task. So, to make my human frame of reference explicit, I will start with my personal experience as a scientist, trying to spread understanding through Vermont society.

## 2. The public scientist, climate change and a holistic world view

I have worked as a researcher in weather and climate for forty years. There is a long tradition that science will lose its integrity, and scientists will lose their impartial reputation, if scientists stray into the domain of public policy. This has concerned me for a long time<sup>4</sup>. This doctrine is comfortable for scientists, because it limits their sense of personal responsibility to their technical field of expertise. It

can be comfortable for those in the policy arena, because science often presents an uncomfortable reality to entrenched ideologies.

The issue of global climate change, which directly involves the interaction of human population, industrial production and economic policy with the earth system, presents a direct challenge to this paradigm. Our human civilization is dependent on ecosystem services, and these are dependent in turn on the earth's climate. The circle became closed once greenhouse gases from global industrial society began to shift the global climate to a new warmer state, with a dramatic long-term impact on the earth's ecosystem<sup>5</sup>. Our scientific understanding of the earth's climate and ecosystems is very incomplete, but it is all we have to guide policy that must look ahead for decades.

The climate change issue presents a direct challenge to traditional human-centered political and economic ideologies, and their implicit authority. Many in the policy arena lack a deep understanding of earth system science; and our global society faces many difficult choices, because our present development path is unsustainable. A holistic vision is needed which draws on expertise across all societies, if we are to move towards a truly sustainable global society. We are moving into a new realm for humanity, there are no authoritative 'experts', and a collective societal change is needed.

## **2.1 Responsibility of scientists to the Earth**

Earth and ecosystem scientists have a broad ethical responsibility in this. I was elected as President of the Vermont Academy of Science and Engineering (VASE) for 2005-2007. In this role, I walked the line between science and policy, trying to help Vermont understand the big scientific picture of global climate change and its impacts on this small northern state. Many in business and politics thanked me, saying that getting an understanding of the big picture helped them realize that fundamental changes of policy are needed. But ironically, some on the political side suggested they are more comfortable listening to advocacy groups than to scientific reality in all its honesty and complexity. But, as a matter of scientific ethics, this is a scientist's role: to present the uncomfortable reality of a complex earth system, whose stability is now threatened by human industrial society.

The fate of the earth should not be left to a struggle between lobbying and advocacy groups who have other agendas, and a rather limited interest in the integrity of the science. Our democratic political system needs to hear from many voices, not just those with narrow self-interests, whether the fossil fuel lobby, or the many environmental groups, or the proponents of an unregulated global financial system. Society needs to hear also from those who see the big picture, which include the science of the earth and its ecosystems; as well as from the many who understand the profound moral issue of our responsibility for the future of the earth. And we must find ways to broaden our collective understanding, so we can make collective as well as individual decisions to change direction.

## **2.2 Responsibility of scientists to the public**

Scientists have a responsibility to communicate clearly to the public, not just to their colleagues and to those in power in society. Without a much deeper understanding of climate change and the earth system, citizens cannot see the need for change, so they cannot support governments when they have to make difficult decisions to move away from 'business as usual'. It is also true that science and society are interwoven. Money for scientific research comes from society, and with it comes an obligation to share what we learn with society. But scientists have the responsibility to both humanity and the Earth to look deeper than society's agendas, and tell the truth as far as we know it, in all its richness and complexity.

I have been funded as an individual for more than thirty years by the National Science Foundation. I have concluded that the scientific community needs to become more deeply embedded in society, if we are to find creative solutions to the challenges that are facing both humanity and the Earth. Certainly scientists need to preserve the very high level of honesty and integrity that is central to science. This may conflict with a culture that often ranks persuasive deception higher than honesty, but integrity is one of the gifts of science to society. Clear communication should be another!

As president of VASE, I committed myself to the public discussion of climate change in Vermont. I was confronted by a public, eager to understand climate change and seeking information, understanding and guidance. The years 2006 and 2007 brought a flood of requests to give talks to schools, citizens groups, business and professional groups, as well as the legislature and the State Climate Change Commission. I became a commentator for Vermont public radio<sup>6</sup>.

### **2.3 Scientists, the media and our communities**

How can we engage our communities, so that they can understand both the local and global aspects of climate change? Late in 2007, the editor of the *Rutland Herald*, Randal Smathers, a community activist, Carol Tashie, and myself met to discuss starting a new Environment section in the paper. We selected the section editor, Elizabeth Gibson, and this new Environment section was launched in January 2008 in the Sunday edition of the two Vermont state-wide newspapers, the *Rutland Herald* and the *Barre-Montpelier Times-Argus*. I have two roles. I am one of the columnists, but I am also the science advisor to the section editor. This gives the Environment section a distinctly different journalistic model. Although we publish a wide variety of ideas and opinions, our emphasis is on scientific and technical accuracy, rather than 'journalistic balance' - which has led to the extensive publication of deliberately deceptive information in the press in the past decade.

The columns I write<sup>7</sup> cover, in an accurate informative way, the broad issue of climate change, as it affects Vermont and the Earth; and they suggest strategies for individuals and communities that could lead to a sustainable society. The framework is holistic: attempting to explain both the underlying science of what is happening, as far as it is known; and how we the people, through our industrial society, are now deeply interwoven with the future of the earth and its ecosystems. My columns go through the seasons, dealing with weather, climate, climate change, energy and policy issues. They blend science with a systems perspective, and encourage the reader to explore alternative and hopeful paths for themselves, their families and society. I have written them so that a scientist will perceive them as accurate (although simplified); while the public can relate their tangible experience of the weather to the much broader issues of climate and climate change. Although they are written for a Vermont audience, which is thoughtful and eager to understand the issues, they are of wider interest to northern latitudes, and to U.S. and global policy discussions. There is always a friendly and valuable struggle with the section editor to balance her perception of the use of language with my need for a precision that means something to the scientific reader, but is transparent to the public. But I go beyond the scientific perspective, and try to frame the choices we face using imagery and emotive and spiritual language.

### **2.4 Social and spiritual aspects**

Humanity needs to recover a value system for balancing human interests with the needs of non-human life and the stability of the Earth system. This statement in itself comes from a view-point where humanity sees itself as separate from, rather than an integral part of the Earth's ecosystem. Across this

planet, there are many different belief systems, but the details mattered little (to the Earth), as long as human impacts were small. In just a few centuries, however, human society has become a major driver of the planetary system. However our belief systems have changed rather little. For example the US has a relatively rigid constitutional system of government, which gives individual human rights and freedoms precedence over the Earth. In parallel, Judeo-Christian beliefs emphasize human uniqueness, and (traditionally) dominion over the Earth. This has been transformed more recently into the concept of stewardship of the Earth; but without understanding or a set of rules, which recognize the need to limit our impact on the earth and its ecosystems, this lacks clear definition.

To make this explicit in the Judeo-Christian context, consider “Thy Will be done on Earth”. This is a clear rule, but we cannot follow it, unless we have some understanding of the earth system, the “Creation”. Specifically we need more than this: because our understanding is still very limited - even though it is growing rapidly with time. We need some rules, guidelines and resilient strategies for managing our impact on the Creation with less arrogance and more humility.

But doesn't humanity have the science and technology to whatever it wishes? Schumacher<sup>8</sup> made the perceptive distinction between the man-made technological world, that we broadly understand and could in principal manage; and the 'created' world, the complex natural world that we are embedded in, but cannot control, in part because our understanding of it is so incomplete.

The issue is fundamentally the same whether we consider it in religious, social or technical language. Because humanity is an integral part of the earth system and dependent on its stability, we do not have the freedom to do what we wish, whatever our political, economic or theological doctrine. It is probable that the response of the Earth system to our human-centered arrogance will be sufficiently large this century that we will be forced to rethink our doctrine. Given the large lags in the earth system, we would be wise to rethink sooner rather than later.

### **3. Managing the human impact on the Earth system**

The human impact on the Earth system is now large enough that it must be managed efficiently. Even though there is uncertainty in our knowledge of the climate sensitivity to greenhouse gases, we have already passed the threshold when the impact this century will be large<sup>9</sup>. If we burn all our coal reserves, without removing the CO<sub>2</sub> from the exhaust gases, we could drive atmospheric CO<sub>2</sub> above 1000 ppm CO<sub>2</sub>. Based on the geological record, this would in time probably melt much of the Earth's grounded ice-sheets and raise sea-level by tens of meters<sup>10</sup>. Still we have not changed direction; and this is because we have not changed our mind-set.

In the biosphere *creation/growth and decay pathways* are well *balanced*. The earth system takes care of itself, and biological processes play a major role. In contrast the human societal focus on maximizing 'growth' and manufacturing, pays too little attention to the decay side of the balance; and as a result, it is unsustainable. We need to establish a balance in which industry and society are fully responsible for everything that humans make. This means a lifecycle analysis, with a clear recycling or remanufacturing pathway. It may require a fast decay of waste into products that are not toxic in the biosphere. It means no accumulation of long-lived by-products that perturb critical planetary balances in the atmosphere, oceans, ice-sheets or biosphere.

Three broad guide-lines or rules for reducing and managing the human impact are:

- a) Minimize lifetime of human waste in the Earth system and eliminate waste with critical biosphere interactions
- b) Minimize the use of non-renewable raw materials; maximize recycling and remanufacturing
- c) Maximize the efficiency with which our society uses energy and fresh water, and maximize the use of renewable resources.

This first general strategy is to *minimize the lifetime of human waste products in the biosphere and Earth system*. This requires an understanding the timescales and biogeochemistry of human waste products, as well as how they impact the coupling and energetics of different parts of the earth system. It is self-evident that our responsibility for our waste-products is not met by simply dumping them in the atmosphere, rivers or oceans or burying in the ground; which have been typical waste disposal methods.

The second strategy, *to minimize the use of non-renewable raw materials*, encourages the development of end-to-end recycling and remanufacture. It can also contribute to achieving the first objective. In this context, the movement towards *relocalization* clarifies issues of end-to-end responsibility, which can easily be lost in a globalized system.

The growth of our population and consumption supported by fossil fuel usage has led to very inefficient use of energy and fresh water. In many regions, fresh water use is more than the Earth system can sustain. So the third strategy is to greatly *increase the efficiency with which our society uses energy and fresh water, and maximize the use of renewable resources*.

#### **4. Synthesis**

I propose that humanity shift to basing collective decisions on Earth system reasoning, rather than traditional economic arguments, because it is likely that we have passed the carrying capacity of the planet. The Earth system (and especially its biological components) is very complex. Although our knowledge and understanding has broadened remarkably in the past thirty years, it is still likely that there are connections and feedbacks we do not yet understand. Unfortunately for humanity, the geological record of the ice-age cycles of the past million years suggests that the climate system is rather unstable to small perturbations - and the human impact is far from small and still growing.

Consequently I suggest the best strategy for dealing with climate change is to minimize the impact of human waste on the natural Earth system, by maximizing the efficiency of human use of materials, energy and fresh water; and as soon as possible shift to dependence on renewable supplies of energy. This will require a profound shift in perspective: away from our current human-centered belief systems and doctrines, to a perspective where we recognize humanity is an integral, but subservient part of the Earth system. The sense of our own power, which we have developed in the past two centuries, is now confronted with the reality that humanity has been unable to manage our impact on the Earth system.

The response of the climate system is also largely beyond our control (although pro-active geo-engineering is of course being proposed); so both humanity and the Earth are faced with major ongoing adaptation. The sooner we rethink our doctrines, and start to re-engineer our infrastructure to minimize our perturbation on the Earth system, based on our regional understanding of climate and the water cycle, the easier the approaching transition will be.

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