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CAN WE MANAGE RESOURCES FOR CLIMATE CHANGE?

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Abstract

Increasing concentrations of 'greenhouse' gases in the atmosphere have the potential to cause relatively rapid changes in regional climates. However, the timing, magnitude and direction of these changes *is* unknown. Medium to long term management of our resources requires that we make decisions now depend on these unknown climatic conditions. Strategies need to be developed that result in management decisions that do not have serious negative consequences if the predictions of climatic change are incorrect. Some aspects of this problem are easier to deal with than others. An example of a strategy for response to potential climate change is presented. Development, acceptance and implementation of a response requires an attitude that facilitates a pro-active and cooperative action.

Pouvons-nous gérer nos ressources en fonction des changements climatiques?

Les concentrations, sans cesse croissantes, de *gaz* "à effet de serre" dans l'atmosphère ont le potentiel de provoquer des changements relativement rapides au niveau des climats régionaux. Cependant, l'échéancier, l'envergure et la direction de ces changements demeurent inconnus. La gestion de nos ressources, à moyen ainsi qu'à long terme, requiert toutefois que nous prenions des décisions dans un avenir rapproché qui vont dépendre de ces conditions climatiques inconnues. Des stratégies doivent donc être développées, afin que les décisions de gestion n'aient pas de conséquences négatives graves, advenant que les prévisions au niveau des changements climatiques soient fausses. Certains aspects de ce problème sont plus faciles à résoudre que d'autres. Cette communication présente des exemples de stratégies de gestion pour répondre aux changements climatiques potentiels. En effet, des stratégies, capables de tenir compte des conditions climatiques futures, pourraient également permettre le développement de plans, pour gérer les ressources en fonction de la variabilité annuelle actuelle du climat.

INTRODUCTION

Global warming is currently a hot topic both scientifically and politically. The Intergovernmental Panel on Climate Change (Houghton et al. 1990) stated that a global warming of 2 to 5^{0}C is likely to occur by the middle of the next century. It is suggested that this warming and associated climate changes will have significant environmental impacts. These include changes in agricultural production (Pulwarty and Cohen 1984), sea level rise (Stewart 1989), movement of forest boundaries hundreds of kilometres north (Graham et. al 1990), and hydrologie problems (Gleick 1989). The Standing Committee of the Environment (1991) of the Canadian House of Commons stated that we must respond immediately by reducing greenhouse gases emissions.

However, there are dissenting viewpoints. Lindzen (1990), Elsaesser (1984, 1988) and Reifsnyder (1989) have stated that the models used to estimate future climates are flawed, and that the projections are unreliable and probably wrong. Reifsnyder (1989), Seitz et al. (1989) and others have suggested that the economic risks in responding to such imperfect projections are too much to bear. Yet others (Idso, 1989; Budyko 1990) believe that if warming occurs it will be beneficial, that "the deserts will bloom", or at least "the return of the deadly glaciers should be delayed indefinately" (Callendar 1938; Ellsaesser 1988) .

This controversy leaves the resource manager and the public confused. However, a state of confusion does not help mangers whose current decisions can have consequences 10 to 100 years into the future. These people need help to deal with the fact that the magnitude, direction, and timing of any changes, particularly at the regional and local level, are unknown (Gates 1985). We must accept that they will have to make decisions based on little information. The key is to be able to make choices that will minimize the risk of creating serious problems if current projections are incorrect (Schneider 1989a,b).

This paper presents a first approximation in the development of a framework for responding to climate change and the management of ecosystems. I make no assumptions about which of the scenarios are possible. The framework would be of equal use whether we have global warming or global cooling. It would also allow us to address current climatic variability.

CAN WE RESPOND TO CLIMATE CHANGE?

We do not live in a museum. Neither climate nor ecosystems are static. Organisms, including humans, have responded to climate changes in the past. It is difficult to say whether these changes had major impacts on human society (Ingram et al. 1991). They have no doubt been important, but adaptation has occurred, and major changes probably only had devastating effects on marginal societies. However, rates of change may have been slower than those predicted for the future. Even though Nature is not in any rush to 'get back to normal', past human societies were perhaps less dependent on constancy and control.

From our perspective (biases), past societies may appear to have been less interdependent, more flexible, and damage was not as 'expensive'. The elaborate technologies, great demands on our resources, and our social structures that presently insulate us from minor climate stresses may actually increase our vulnerability to major stresses (Bowden et al. 1981). However, our large knowledge base, our global communications capability and transportation network may provide the ability to respond to change. Unfortunately, we persist in being surprised when adverse weather results in problems. We dislike uncertainty, we believe that change is bad, we hope that nature is benign, and we assume that we are in control.

Trist (1980) describes four modes of response to stress. They are: inactive (wait and see), reactive (restore the lost good old days), preactive (predict and prepare for the better future), and interactive (building the future upon a pro-active and cooperative response). All these modes are apparent in the present debate on climate change. I believe that the interactive approach is the way to respond to climate change.

We can respond to the greenhouse gas induced climate change in three ways. We can: 1) reduce emissions of carbon dioxide and other greenhouse gases; 2) slow the rate of increase of these gases in the atmosphere by increasing their rate of absorption from the atmosphere; and 3) adapt to the changed climate. From a global perspective a mixture of all three options is required.

Response to climate change via option 1 will require political decisions, societal changes and technological advances (Schneider 1989b; Victor 1991). Option 2 includes planting trees to increase land based absorption of carbon dioxide (Sedjo 1989). However, Schroeder and Ladd (1991) estimate that it would require about 200 million hectares of new forest land to absorb the United States' annual anthropogenic carbon dioxide emissions, and these trees would have to have a productivity greater than any forests in Canada. Discussion of options 1 and 2 is beyond the scope of this paper. These options are also beyond the control of most resource managers. *I* will consider option 3 in regards to managed ecosystems.

POSSIBLE CHANGES IN ECOSYSTEMS

A wide range of responses by ecosystems can be expected if the climate change predictions are correct. From the manager's perspective there are direct effects, e.g., changes in plant growth, and indirect effects, e.g., changes in frequency of fire and disease. Adaptation to change may be easier with managed ecosystems, rather than unmanaged ones, since intervention is often part of management. Migration rates of trees are slow (Graham et al. 1990) making adjustments in unmanaged ecosystems uncertain.

However, established vegetation is fairly resilient to changes in climate. This is seen in the ability of ecosystems to withstand present year-to-year variations in weather conditions. These variations are often greater than proposed climate changes. Consequently, dramatic changes with large scale devastation of plant communities are unlikely. Populations of plants and animals at the edges of their ranges are likely to be the most sensitive to climate changes.

Animal populations may be able to move more rapidly than plant populations in response to a change. However, this requires that appropriate habitats be available in other areas. Also, fragmentation of habitat will make it difficult for even resilient populations to move and adapt (Peters 1989).

Climate change may not necessarily be gradual. The climate may rapidly jump from one mode to a much different one (Schneider 1989a, Wiman 1990). Often, only changes in seasonal and annual means of temperature and precipitation are considered (Gates 1985). However, the extremes are also important. They and other climate variables such as wind will change. Different weather patterns, and storm frequencies can be expected.

All changes can not be considered negative. In some regions, changes in climatic conditions could be an improvement over existing conditions, resulting in increased productivity of the vegetation. It has been suggested that the increased carbon dioxide concentration may directly increase water use efficiency and growth of plants (Idso 1989; Graham et al. 1990).

A STRATEGY FOR RESPONDING TO CLIMATE CHANGE

Responding to climate change depends on the capability of the resource as much as the capabilities of the managers. Appropriate responses will have a mix of prescriptions. They can be grouped under adaptation (roll with the punches), mitigation (fight back) and protection (wear armour). The mix depends upon the situation and the values (desires, beliefs, mandate) of the individual or organization planning the response. Prescriptions must be flexible and be safe-fail, i.e. if they fail they fail manageably (Holling cited in Wiman 1990).

No single approach will work for all situations. Different emphasis will be placed on the adaptation/mitigation/protection prescriptions. There will be situations that have only 'internal' repercussions. In other situations actions will have external influences, e.g. erosion into a water course. There will be situations were external factors will affect the manager's options for response, e.g. water availability from a common supply.

The steps in a response strategy are:

1. Identify the issue of concern.

2. Determine the level(s) of change in the resource that is of concern, including external impacts and costs.

3. Estimate how the resource may respond to specific climate scenarios. Past extreme weather conditions can be used as analogues.

4. Determine the response required to adjust for the changes in the resource, and the cost of this response.

5. Assess if future problems can be avoided by action(s) taken now.

6. Determine if current knowledge and technology are adequate to respond now or in the future.

7. Perform the research/development required to produce the required information and/or technology.

8. Monitor the resource to determine if changes are taking place, and when the threshold for concern and intervention have been reached.

This strategy involves a simple, logical procedure of defining the problem, analysing the outcome, and being ready to respond. Steps 2 and 8 are key to making the strategy work. Unfortunately, we rarely do step 8.

I will present an example that relates to reclamation to illustrate how this process might work, though I admit that I do not know much about reclamation. I have chosen to assess the effect of climate warming on re-vegetation of a denuded area.

1. Issue: A change in the vegetation community on a reclaimed area.

2. Concern: Greater than 30% reduction in cover due to death of the vegetation could result in water and wind erosion. Eroded material may contaminate nearby wetland habitat. The resulting bad publicity would affect the ability of the company to operate in the future. The cost of rehabilitating the wetlands would be expensive.

3. Scenarios: A warming of 2 °C with a 20% reduction in summer precipitation. Similar conditions in the past have resulted in death of certain plant species and a loss of cover. There was little invasion by more tolerant species since they are not common locally.

4. Response at the time of change: Plant more drought tolerant species of plants to replace those that are dying. The cost of production and planting of the replacement plants must be determined. Will suitable species be able to invade?

5. Adjustments to make now: Can we modify current practices so that they are more resilient, e.g., species mixes? Will other species provide adequate growth now, while also being appropriate for the new conditions? What is the cost of a revised practice compared to the future rehabilitation cost? Are other benefits obtained? What is the cost if the response was not required?

6. Present capabilities: Is our current knowledge adequate to determine which species may be appropriate for the new climate? Do we need to develop a program to find and produce sufficient number of suitable plants, and what is the cost?

7. Research and development: Perform as required.

8. Monitoring: Determine and implement an appropriate monitoring protocol to assess vegetation changes.

The above example is only a skeleton of a full assessment. Other factors will have to be considered. The plan will require revision as new information and technology are developed.

CONCLUSIONS

Will we be like the foolish virgins of the parable and not consider the future implications of our actions? Or, will we be like Prometheus whose name means 'he-who-possess-forethought' (Wiman 1990)? We must respond within the limits of any new environmental conditions not against them. A mix of actions will be required now and in the future. Immediate responses include deciding what degree of change in the resource constitutes a problem, determining possible solutions, and initiating monitoring programs to determine when intervention is required. Also, we need a non-predjudicial attitude and a 'what is' not a 'what should' frame of mind.

Implementation of a strategy to respond to climate change cannot be avoided. The public, politicians and shareholders require answers. Our global experiment is underway. We will find out how the Earth's climate and ecosystems respond.

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