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CONSEQUENCES OF CLIMATE CHANGE

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ABSTRACT

This paper provides a comprehensive overview of the state of the science in estimating potential effects of climate change on the human environment. The paper provides an overview of the state of effects research and outlines the analyses required in order to make adaptive policy. It compares approaches that have been taken for measuring the human consequences of climate change, and outlines the results of climate change impact studies that have been performed both on individual sectors and entire regions.

The paper also discusses both the results of studies of historical environmental changes that serve as analogs for potential future climate change and the major sources of uncertainty. The paper concludes with a summary of effects, knowns and unknowns, and directions for future research. In general, future effects research needs to be targeted on regions rather than individual resources; it must take the timing of resource effects and technological change explicitly into account; and it must directly address uncertainty using new and more efficient computational techniques, as opposed to brute-force Monte Carlo estimation.

KEYWORDS:

Climate, Environment, Temperature, Global Warming

INTRODUCTION

This paper is concerned with the potential effects of climate change on the human environment. Although much has been written in both the scientific literature and popular press concerning the 'greenhouse effect' and its potential consequences for natural and human resources, and although other overviews of impact studies exist

In the agricultural sector, higher temperatures would likely result in increased energy demand for irrigation pumping, but reduced demand for crop drying. Industrial energy demand is largely insensitive to either weather or climate, although industrial output (and actual energy usage) may be supply-constrained by severe weather. Existing statistical analyses have not explored the relationship of transportation energy demand to climate, but warmer winters should increase transport activity and energy demand. Warmer summers should tend to increase the use of mobile air conditioners and energy demand [as well as the demand for chlorofluorocarbons (CFCs) or CFC substitutes].

The production of conventional oil, gas and coal is unlikely to be affected by climate, although less severe winter conditions could lower Arctic region supply costs. One effect that could increase Arctic costs is permafrost decay, which could create problems for infrastructure such as pipelines. The availability and operation of hydroelectric power could be indirectly affected by climate through precipitation and evaporation patterns. Changes in hydrology and average climate could similarly affect the availability and design of power plant cooling systems.

The production capacity of renewable energy supplies, such as solar, wind, ocean thermal energy conversion (OTEC), and biomass, is potentially more sensitive to climate change than conventional energy supplies. Temperature, cloud cover, wind vectors, and their associated variances affect the production of solar, wind, and OTEC energy. It is unclear whether the combination of increased CO2 and changed climate would increase or decrease total energy productivity from biomass. Biomass waste as an energy source could be affected by productivity of forests. Average temperature and pressure conditions can also affect the availability of recoverable methane release from landfills.

The impacts of climate change on regional water supply and demand are uncertain. GCMs indicate possible changes in average annual precipitation for any given region on the order of plus or minus 20 O/O. Since runoff is essentially the difference between precipitation and evapotranspiration (which increases with higher temperatures), impacts on runoff can be even greater. Where runoff decreases, water quality in streams and rivers will decline unless pollutant loads also decrease.

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Water use in urban and suburban areas will probably increase with increasing temperature. In agriculture, irrigators would tend to use more water to compensate for higher transpiration rates, although higher CO2 levels reduce transpiration increasing the plant's resistance to vapor transfer into the air.

The relative values of water for alternative use will Likely change. Drinking and domestic uses will remain top priorities, but changes in seasonal and annual supplies may alter the relative benefits of allocating water and reservoir capacity to flood control, power generation, fish habitat, or consumptive uses such as irrigation. Hydroelectric power might become more attractive as a means of both abating the greenhouse effect and adapting to increased power demands that might accompany it. However, supplying this increased hydroelectric power would depend upon the availability of water at existing hydroelectric sites and/or appropriate new sites, which are becoming increasingly scarce in many parts of the world.

Adaptations to climate change could involve construction of new dams and reservoirs, inter-basin transfers of water, and development of 'unconventional' sources of water - e.g. desalinization; recycling of industrial, municipal, and agricultural waste water; and weather modification. Lacking sufficient guidance on the specifics of future climatic conditions, water managers and planners are unlikely to invest in any of these measures unless factors other than climate change already justify them. However, water managers may already be willing to invest in techniques that improve the operation of existing infrastructure and in research and technological innovations to accomplish this end.

Anticipated global warming could occur in a matter of decades, possibly outrunning natural rates of forest migration, which occur on millennia1 time scales. If so, existing forests will become increasingly stressed and more susceptible to pest infestation, disease, and eventually, fire (Clark 1988). Gradually, existing forests will be replaced by other forms of vegetation or by forests with a different species mix.

Tree growth is generally limited by lack of summer warmth in the high latitudes and by heat and lack of water in the mid-latitudes. The effects on forests would likely be modest in the tropics, where temperature changes are expected to be least. With global warming, the boreal forests would likely migrate northward onto the currently unforested tundra, provided adequate precipitation and soils exist. Simulations indicate that the greatest transitions occur at the boreal/cool temperate border. Some mid-latitude forests could disappear, especially if the projected increases in tree growth and moisture-saving effects of high CO2 and improved plant water use efficiency do not materialize. Warming in mountainous terrain would cause species to move to higher elevations.

Rapid change in climate threatens to reduce ecosystem biodiversity. Some existing species of plants and animals would be unable to adapt because they are not sufficiently mobile to migrate at the rate required for survival. While the economic value of biodiversity is difficult to quantify, it is undoubtedly substantial.

Adaptation of the forest sector to changing climate will not be simple, but would likely include earlier harvests of unsuited species and salvage operations in older stands; seeding and thinning (which are costly) in younger stands; and active planting of trees adapted to hotter and drier (or wetter - it is not clear which) climates in harvested stands. Introduction of new varieties is a much slower process in forestry than in agriculture. At least in the first decades, adaptation may involve changes in the species mix that could require costly adjustments in the logging and processing industry. Also, the long growing periods for trees add the economic risk of inappropriate species choice for changing climate conditions, inhibiting investment in trees and mills to process them. The geography of production forestry will change, with some regions becoming increasingly important sources of forest products while others decline. Active management of forests will be limited to those areas where high yield plantation forestry can continue to be practiced profitably.

DISCUSSION

Other unmanaged terrestrial and freshwater ecosystems have nonmarket value to humans because of their uniqueness (e.g. they may be protected in national parks), their value in maintaining genetic and biotic diversity and the general ecological context they provide for natural resources exploited by humans. Analyses have suggested that greenhouse warming may affect worldwide distribution of vegetative life zones and biotic communities, including not only forests but also grasslands and tundra and arid communities.

Arid lands are considered particularly sensitive. In paleoecological studies, changes in past climates have been found to strongly influence vegetative patterns. Concern is growing over the effects of global warming on highly specialized terrestrial species, species with poor dispersal mechanisms, and alpine and arctic communities. Effects of global warming on aquatic communities are currently unknown, but because these communities are strongly tied to their terrestrial settings through energy, nutrients, and water changes in terrestrial vegetation could have pronounced effects on freshwater systems.

The responses of yield to various stresses have been well defined through experimentation in many crops. Quantifying these responses, and identifying when agriculture is most vulnerable to stress, is beneficial in helping to identify the most efficient strategies for adaptation. Crop-level adaptation to climate change is expected to be key in minimising future yield losses and may involve: changing crop cultivars, sowing time, cultivation techniques, and/or irrigation practices. Ongoing research is addressing the challenges of maintaining and/or increasing crop production under global change. Some risks to crop production from climate change and extreme weather events have been identified and strategies suggested tohelp maintain production. These include: restoring farm type, crop, or cultivar scale diversity into food systems, to improve their resilience and making crop improvements that enhance stress tolerance. Other strategies may include developing pre-defined, international responses to food shortages in order to prevent food price shocks that might reduce people's access to food.

There are eight national missions that would form the core of the national plan. These include national missions for solar energy, enhanced energy efficiency, sustainable habitat, conserving water, sustaining the Himalayan eco-system, a "Green India", sustainable agriculture and strategic knowledge platform for climate change. However, there are some innovative responses by water utilities to address these climate change risks and it has resulted in pushing the frontiers in a number of areas. It includes desalination, re-use and storm water harvesting and aquifer recharge. It would be worthwhile to give high priority to "more crops per drop" approach, rainwater harvesting, aquifer recharge, revival of water bodies and conservation technologies. In the last decade, the Central Government has tried to address the issue through several initiatives such as subsidies for micro-irrigation (which optimizes water usage for agriculture), national watershed development project for rain fed areas and artificial recharge to ground water through dug wells in hard rock areas and rural water supply enhancement programmed through the catchment area approach.

CONCLUSION

Global climate change is not a new phenomenon. The effect of climate change poses many threats; one of the important consequences is bringing about changes in the quality and quantity water resources and crop productivity. It can be concluded that the Indian region is highly sensitive to climate change. Agriculture sector is the most prone sector as it will have a direct bearing on the living of 1.2 billion people. India has set a target of halving greenhouse gas emissions by 2050. There is an urgent need for coordinated efforts to strengthen the research to assess the impact of climate change on agriculture, forests, animal husbandry, aquatic life and other living beings.

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