Abstract

Strategies to mitigate anthropogenic climate change recognize that carbon sequestration in the terrestrial biosphere can reduce the build-up of carbon dioxide in the Earth's atmosphere. However, climate mitigation policies do not generally incorporate the effects of these changes in the land surface on the surface albedo, the fluxes of sensible and latent heat to the atmosphere, and the distribution of energy within the climate system. Changes in these components of the surface energy budget can affect the local, regional, and global climate. Given the goal of mitigating climate change, it is important to consider all of the effects of changes in terrestrial vegetation and to work toward a better understanding of the full climate system. Acknowledging the importance of land surface change as a component of climate change makes it more challenging to create a system of credits and debits wherein emission or sequestration of carbon in the biosphere is equated with emission of carbon from fossil fuels. Recognition of the complexity of human-caused changes in climate does not, however, weaken the importance of actions that would seek to minimize our disturbance of the Earth's environmental system and that would reduce societal and ecological vulnerability to environmental change and variability.

Keywords: Climate change; Carbon sequestration; Land use change; Land surface change; Surface energy balance

1. Introduction

Human activity is vastly altering the Earth's vegetative cover. Such changes have considerable consequences for the health and resilience of ecosystems and for human welfare. They also contribute to anthropogenic climate change through a variety of processes. These include the growth or degradation of surface vegetation, which produces changes in the global atmospheric concentration of carbon dioxide; and changes in the land surface, which affect regional and global climate by producing changes in the surface energy budgets. These latter impacts are not currently being incorporated into the development of climate-change mitigation policies. Recent studies suggest that changes in the surface energy budgets resulting from land surface change can have a profound influence on the Earth's climate. Acknowledging the impact of changes in surface energy budgets raises the importance of treating land surface change as a component of climate change. However, it also makes it more challenging to create a system of credits and debits wherein emission or sequestration of carbon in the biosphere is equated with emission of carbon from fossil fuels or other sequestration of carbon.

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) defines "climate change" as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere. . . " (UNFCCC, article 1.2, 1999). In contrast, the Intergovernmental Panel on Climate Change (IPCC) defines climate change more broadly and includes reference to land use change: "climate change refers to a statistically significant variation in either the mean state of the climate or in its variability. . . Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC, 2001).

The elements of climate include global average surface temperature; global average sea level; the frequency, intensity, and location of extreme events; the length of the regional growing season; soil moisture; above- and below-ground biomass; local precipitation, etc. Climate change is occurring at all spatial scales from local to regional to global. Human society is currently helping to produce a global climate for which there is no precedent in the historic or prehistoric records. Given the magnitude,