Analyses and trends of forest biomass in higher Northern Latitudes

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Abstract Information on forest volume, forest coverage and biomass are important for developing global perspectives about CO_2 concentration changes. Forest biomass cannot be directly measured from space yet, but remotely sensed greenness can be used to estimate biomass on decadal and longer time scales in regions of distinct seasonality, as in the north. Hence, in this research, numerical methods were used to estimate forest biomass in higher northern regions. A regression model linking Normalized Difference Vegetation Index (NDVI), to forest biomass extracted from SPOT/4 VEGETATION data and PAL 8km data in regional and continental area (N40-N70) respectively. Statistical tests indicated that the regression model can be used to represent the changes of forest biomass carbon pools and sinks at high latitude regions over years 1982-2000. This study suggests that the implementation of estimation of biomass based on 8-km resolution NOAA/AVHRR PAL and SPOT-4/VEGETATION data could be detected over a range of land cover change processes of interest for global biomass change studies.

Key words: woody biomass, NDVI, regression model, climate

Introduction

In recent years an increasingly heated international debate on climate change has developed, with every country from the developing to the developed world affected. As a significant producer of natural resources as well as an exporter of the same, Northern forests in latitudes between N40^{o} - N70 ^{o} will be among the most affected whatever the results of this debate. With this increasing debate about carbon production, particularly as the national debate on the ratification of the Kyoto accord continues, there are many areas in which research is required. Forests play a major role in the global carbon budget because they dominate the dynamics of the terrestrial carbon cycle. The terrestrial sinks of carbon continue to be problematic in their estimation, although there are growing in dications to explain the role of the terrestrial biosphere in the “missing carbon sink”. The land carbon sink could be distributed among various carbon pools-vegetation, soil, etc. Studies are currently afoot for assessing the use of forest biomass sinks to sequester carbon as part of global mitigation effort. These studies emphasize the importance of forests in the carbon cycle and the need to quantify, measure, monitor, and manage carbon pools in forests. One particular area is in the bulk quantification of forest biomass, as it is a vital quantity in the estimation of carbon sink through photosynthesis on global scale. There is need to understand the global environmental system and in particular the circulation of carbon in nature, as well as how human activities have modified it, to assess how humans may do so increasingly in the future. Robust techniques are needed for mapping carbon stocks and fluxes with lower cost in view of the stated scientific and political tones of this theme. Because of the aforementioned problems, it is important to characterize and choose statistical techniques appropriate for estimating forest cover and forest biomass and subsequently interpret the results in order to understand the relationships between changes in climate and the terrestrial northern forests.

Methods

Many studies investigated the relationship between the NDVI and annual climatologically indices of temperature, precipitation and radiation at a global level [1]. NDVI is often considered primarily a function of climate, terrain, ecosystem and hydrology variables [2]. The NDVI meridional profile was analyzed in relation to the temperature and precipitation profiles in two transects. In the 75^{o}E transect, high positive (0.79) and negative (-0.58) correlations were found in the NDVI-precipitation and NDVI-temperature Wi^{o} meridional profiles, respectively [3]. Many studies have shown that NDVI correlated well with two or three month cumulative precipitation [4]. Year –to-year changes in biomass are quite small, unlike year-to-year changes in greenness, which can vary from 5 to 10% relative to the seasonal average due to climate variability [5]. This research describes an analytical model linking boreal forest biomass and NDVI[6]. Such model may help to the better understanding of NDVI as a useful indicator of forest biomass and, to determine the sensitivity of the various forest biomass to climate variability.

$$V = \alpha D^{\beta} H^{\gamma} P^{\omega} Temp^{\varphi} \qquad (1)$$

$$V = \alpha D^{\beta} H^{\gamma} (F(NDVI))^{\omega} (F(NDVI))^{\varphi} + E \qquad (2)$$

The equations (1) and (2) are applied to PAL NDVI data to evaluate biomass change in northern temperate and boreal forest (N40-N70).

Results and discussions

The mean biomass values are 115Gt and 124Gt respectively for 80s and 90s respectively (figure 1). Next biomass estimates were converted to carbon by multiplying by 0.5, a standard factor for converting woody biomass to carbon (TBFRA-2000, 2000). We estimate the biomass carbon pool in the woody biomass of temperate and boreal forests in the Northern Hemisphere to be 57.5GtC during 1980s and 62GtC during 1990s.From the analyses, the mean value of boreal forest coverage and boreal forest biomass is increasing in the 90s (figure2). It argues that there is increasing greenness in North. Uncertainties in our estimates of forest coverage and biomass pool changes must be evaluated by comparing these to national, provincial and state estimates.

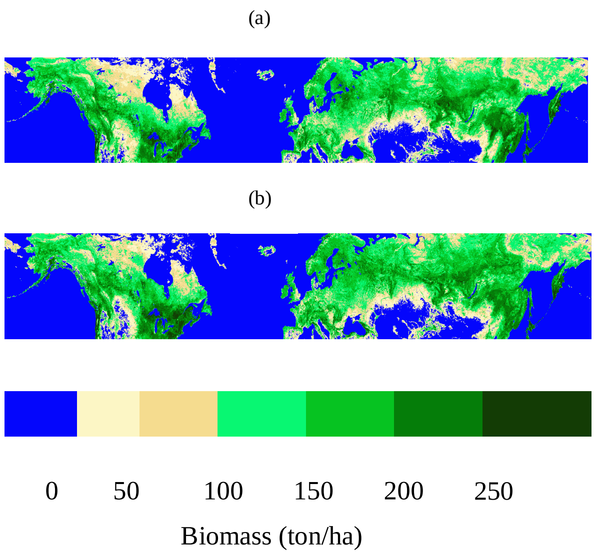

Fig1 Change woody biomass of northern temperate and boreal forests between 1980s (*a*) and 1990s (*b*).

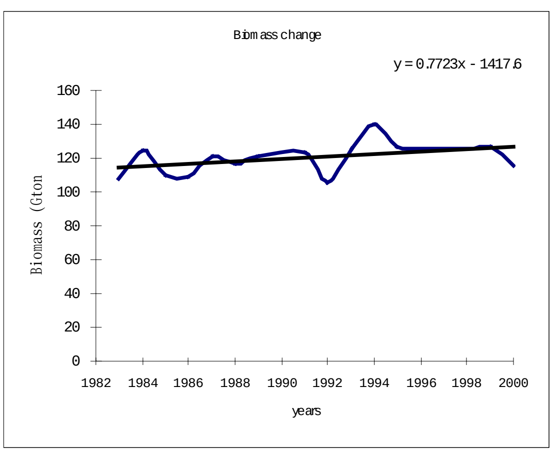

Fig2 Boreal forest biomass change over years 1982-2000 in North (N40-N70)

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