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Dynamic forest vegetation models for predicting impacts of climate change on forests: An Indian perspective

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ABSTRACT: Understanding climate change vulnerability of Indian forests has received wider attention in recent years and a number of assessments with different approaches have emerged over time. These assessments have mostly used climate-sensitive vegetation models to explain the climate change impacts. In these studies, trees constituting a particular forest are often clubbed together into small number of groups having similar functional traits referred as Plant Functional Types (PFTs). Most of the Forest Vegetation Models (FVMs) are still in their developmental stage and there have been attempts at various levels to develop more versatile and precise models. Several developing countries, including India, still lag behind in developing dynamic vegetation models (DVMs), which could be appropriate for the local applications to predict the impact on forests at regional level. This is restrained mainly because of the lack of long-term observations with respect to various interacting biotic, abiotic and climatic (or environmental) variables in a forest ecosystem, like water and nitrogen use efficiency, response to elevated concentration of CO_2, nutrient cycling, net primary productivity, etc. The observations on influence of the environmental variables on forest ecosystems are available in discrete form. Existing FVMs integrate observations more appropriately for their place of origin for which they have been developed. Different types of forests in different climatic zones are supposed to respond differently to climatic changes. Hence, it is imperative that models are developed for the specific biogeographic regions in order to predict the influences more accurately. It may not be wise to use existing FVMs in their pristine form for all of the region without considering the regional influences. Various challenges associated with the usage of the generic models of external origin with special reference to Integrated Biosphere Simulator (IBIS) model - being widely used and accepted in Indian policy documents- is presented in this paper. We also discuss on the need for developing a regional FVM for climate change impact studies, so that the impact prediction is more precise and reliable.

KEYWORDS: Climate change, Dynamic Vegetation Models (DVMs), Forest Vegetation Models (FVMs), Integrated Biosphere Simulator (IBIS), Plant Functional Types (PFTs)

INTRODUCTION

Scientific literature is a buzz with the Forest Vegetation Models (FVMs) to evaluate the impact of climate change on forests. Many FVMs such as Species Distribution Model (SDM), Gap Model, Landscape Model, Biogeochemical (BGC) model and Dynamic Global Vegetation Model (DGVM) have been developed and implemented to assess the impacts of the climate change on forests (Arora and Boer 2005; Bachelet et al., 2001; Bonan 1996; Brovkin et al., 1997; Cox 2001; Foley et al., 1996; Friend et al., 1997; Levis et al., 2017; Sato et al., 2007; Sitch et al., 2003; Woodward and Cramer 1996). FVMs have gradually evolved to imitate exact response of forest under various levels of stimuli including climate change. However, current FVMs lack integration of complex process of dispersal, attacks of insects and pathogens, regeneration, etc. in an explicit way. Hansen et al., (2001) stressed the need for examining the population processes (e.g. dispersal and regeneration) that would mediate the responses of organisms to environmental change. Simulation results of FVMs, which have shown considerable acceptance, mimicking real situation need to be validated for different regions and on different scales. Well-validated robust models provide inputs for integrating and prioritizing actions at policy level for forest managers. Forest managers in India are looking forward for well-validated models to integrate the output at policy level. This has been limited by testing of just few models like Integrated Biosphere Simulator (IBIS) and Lund Potsdam Jena (LPJ) (Chaturvedi and Gopalakrishnan 2011; Devaraju et al., 2011; Upgupta et al., 2015). IBIS in particular has been referred widely in climate change policy documents of India.

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