A BIOME CLASSIFICATION OF CHINA BASED ON PLANT FUNCTIONAL TYPES AND THE BIOME3 MODEL

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Keywords: Desert, Ecoregion, Environmental attributes, Forest, Global change, Grassland, Vegetation classification

Abstract: A biome classification for China was established based on plant functional types (PFTs) using the BIOME3 model to include 16 biomes. In the eastern part of China, the PFTs of trees determine mostly the physiognomy of landscape. Biomes range from boreal deciduous coniferous forest/woodland, boreal mixed forest/woodland, temperate mixed forest, temperate broad-leaved deciduous forest, warm-temperate broad-leaved evergreen/mixed forest, warm-temperate/cool-temperate evergreen coniferous forest, xeric woodland/scrub, to tropical seasonal and rain forest, and tropical deciduous forest from north to south. In the northern and western part of China, grass is the dominant PFT. From northeast to west and southwest the biomes range from moist savannas, tall grassland, short grassland, dry savannas, arid shrubland/steppe, desert, to alpine tundra/ice/polar desert. Comparisons between the classification introduced here and the four classifications which were established over the past two decades, i.e. the vegetation classification, the vegetation division, the physical ecoregion, and the initial biome classification have showed that the different aims of biome classifications have resulted in different biome schemes each with its own unique characteristics and disadvantages for global change study. The new biome classification relies not only on climatic variables, but also on soil factor, vegetation functional variables, ecophysiological parameters and competition among the PFTs. It is a comprehensive classification that using multivariables better expresses the vegetation distribution and can be compared with world biome classifications. It can be easily used in the response study of Chinese biomes to global change, regionally and globally.

INTRODUCTION

Biome, a physiognomic class of a set of ecosystems, describes a set of ecosystems within a geographical region exposed to the same climatic conditions and having dominant species with a similar life cycle, climatic adaptations, and physical structure (STOLZ et al. 1989). The set of ecosystems includes not only plants, but also animals. Generally, plant communities cover most areas of the ecosystems. Vegetation mapping, therefore, can be used as a surrogate for biome mapping.

Biome classification has long been investigated by ecologists at regional and global scales. The best-known schemes are those of the life-zone classification system (HOLDRIDGE 1967), world biogeographical biomes (UDVARDY 1975), world ecosystems (OLSON et al. 1983), main types of the world ecosystems (MATTHEWS 1983), continental ecoregions (BAILEY 1989), terrestrial biomes (STOLZ et al. 1989), and the ecozones of the world (SCHULTZ 1995). Past and future changes in atmospheric composition, climate and human land-use can exert large
effects on the distribution and functioning of terrestrial vegetation (MELILLO et al. 1996). Biomes based on the transcontinental correspondence between geographic patterns of vegetation and climate become an important concept in the study of global change. Biomes have been used to predict broad physiognomic vegetation types by biogeography, biogeochemistry and dynamic global vegetation models (e.g. WOODWARD & WILLIAMS 1987, PRENTICE et al. 1992, NEILSON 1995, WOODWARD et al. 1995, HAXELTINE & PRENTICE 1996, BOX 1995, 1996, FOLEY et al. 1996, BEERLING et al. 1997). However, for a global change study no obvious choice for a vegetation map exists in the world (HAXELTINE & PRENTICE 1996). The few available global vegetation maps are inconsistent with one another, both in their choice of biome definitions and in the areas assigned to a biome on which they agree. Not one of these maps is accepted as being superior to another. More detailed and authoritative maps are available for specific continents or countries, but there are major inconsistencies between the biome definitions used in different countries (PRENTICE & WEBB 1998). A great deal of effort seems to have gone unrewarded in vegetation mapping and description because the categories used by existing vegetation schemes are vague and often unsuited to the tasks for which the data will be used (ADAMS 1996). Furthermore, the vegetation schemes used in different countries and by different scientist are usually incompatible with one another. The categories in regionally-focused schemes also do not tend to nest easily into any broader-scale categories, so it is impossible to get any meaningful overview of the changing ecology of regions or of the world as a whole (ADAMS 1996).

Recently, plant functional types (PFTs) has become a highly-used phrase in the study of global change. PFTs are functionally similar plant types which can be used in global ecological modeling (BOX 1996). The easiest approach to classifying PFTs may be a structural-functional one, since it permits the use of visible structural attributes as surrogates for functional patterns (BOX 1996). Namely, these functional types are related to the physiognomy of plants (WOODWARD & Cramer 1996). Other approaches which are more strictly in relation to the function, include a physiological emphasis (BOX 1996), indicating those processes by which the plant carried out its activities, e.g. the different processes of photosynthetic CO2-fixation C3, C4 and CAM (WOODWARD & CRAMER 1996). The definition of PFTs is closely related to spatial scale, i.e., there are different PFTs at different scales such as local, regional and global levels. Some practical criteria for world sets of PFTs (BOX 1995, 1996), needed for global ecological modeling, can be suggested: (1) The PFTs should represent the worlds most important terrestrial plant types, i.e. major elements in natural (and perhaps some secondary) vegetation and ecosystems. (2) Such plant types must be characterized through their functional behavior and attributes. (3) The set of PFTs should, as a whole, provide complete, geographically-representative coverage of the main vegetation types of the worlds land areas. For a current global change study, PFT is an important concept to maximize our potential to predict accurately the responses of real vegetation to global change with real species diversity (SMITH et al. 1997). However, the use of PFTs for biome classification has not been reported so far.

China covers about 10% of the total world area and has abundant vegetation types including most of the world vegetation types which range from the boreal coniferous forest in the north east to the tropical rain forest in the south, from the temperate steppe in the central north to the desert in the west, and special alpine and subalpine vegetation on the western mountains, especially on the Tibetan plateau (EDITORIAL COMMITTEE FOR VEGETATION OF CHINA 1980). Chinese ecologists have studied vegetation or biome classification in China since the 1950s