Critical knowledge gap when predicting vegetation change along with global climate change with special reference to boreal forest

Satoru Kojima[1]

[1] NORA

It is a widely accepted notion that the global vegetation will be substantially affected and the geographical shift of vegetation will likely occur if the global climate warming takes place as predicted by IPCC (1995, 2001, 2007). A number of studies have been conducted to predict how global vegetation would change along with the warming and maps showing the possible vegetation distribution under the warmed climate have been proposed (Bolin et al., 1986; Solomon, 1992; Cramer and Leemans, 1993). Because the magnitude of the climate warming is expected to be most pronounced in the high latitudes of the northern hemisphere, out of the biomes of the world, the boreal forest, subarctic forest-tundra, and arctic tundra would be those most severely affected by the climate warming. A substantial spatial change of those biomes, mostly reduction replaced by other vegetation such as steppe grassland intruding from the south, is speculated (Sargent, 1988; Rizzo and Wikens, 1992; Solomon, 1992; Cramer and Leemans, 1993).

However, there are some inherent problems as to those vegetation change predictions. Most of the vegetation change scenarios are based on direct correlation of vegetation and the present climate conditions by employing models such as Holdridge (1947, 1967), Whittaker (1967), Box (1981), or in some cases Koppen's classification. It is no question that vegetation is controlled by regional climate. But it is also, or more directly, regulated by soil characteristics. For instance, soils associated with the boreal forest (i.e., Podzol, Brunisol) are very different from those of the steppe grassland (i.e., Chernozem, Luvisol). Their physico-chemical properties are totally different. For example, soils of the boreal forest are mostly acidic with soil pH usually less than 5 whereas those of the grassland are circum-neutral or even alkaline as soil pH more than 6. This indicates that soil base status of the grassland is much higher than that of the forest. Thus, it is difficult to accept the prediction that boreal forest will readily change to the steppe grassland, even if the climate becomes warmed as predicted, unless soil properties change suitable to the grassland ecosystem. Yet, most of the vegetation change scenarios did not respect this aspect so much.

The current climate warming issue due to the GHGs increase from anthropogenic activities is an unprecedentedly fast change we have ever experienced as it will happen by the end of the 21st Century, i.e., a change in a 100 year-scale. On the other hand, pedological changes require thousands of years (Bolin et al., 1973). Then what would happen to the vegetation in the meantime when climate alone becomes warmed while soil characteristics remain virtually unchanged.

In my talk, I would like to discuss about this critical knowledge gap, taking examples from the cases of northern North America, in particular, northern Alberta and Yukon Territory, Canada.