SECTION 7

The Effects on Holdridge Life Zones

7.1. Introduction

This section considers the transitional areas between life zones of the Holdridge ecological classification system and identifies the location and extent of areas that might be affected under given scenarios of long-term climatic change.

Holdridge (1947, 1967) proposed a life zone classification to predict the potential vegetation of a region for values of climatic indices. The Holdridge classification is based on the principle that different types of vegetation have different, yet definite, climatic and edaphic requirements in which the climatic usually overshadow edaphic factors in conditioning large-scale patterns and sensitivity to change. In particular, the system is based on two factors: mean annual precipitation and mean annual biotemperature, the latter defined as the mean of unit-period temperatures with substitution of zero for all temperature values below 0 °C and above 30 °C, respectively. A "life zone" is objectively defined as an area that falls within specified ranges of mean annual precipitation and mean annual biotemperature, and which consists not only of vegetation, but also soils, geology, topography, atmospheric influences and animal activities (Holdridge, 1967).

A classification that recognizes the dependence of natural vegetation on climatic factors provides a basis for constructing maps to display the impact of climatic changes on the geography of the major vegetation zones (cf. Emanuel *et al.*, 1985). In this section we use the Holdridge system to consider the possible sensitivity of the distributions of terrestrial ecosystem complexes to changes in precipitation, especially in those areas where the shifts in their boundaries are likely to be significant agriculturally.

Three maps using the Holdridge classification will be compared for Chimborazo Province, Ecuador: one derived from soils data and representing recent conditions, one for a change of climate toward more moist long-term conditions, and one for a change of climate toward drier long-term conditions (these scenarios were discussed and defined in Section 2, above).

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7.2. The Holdridge Life Zone Model

The underlying postulate of the Holdridge system is that the primary influences on vegetation are those elements that make up climate. In this respect, it is not unlike the systems of Köppen (1931), Clements (1920), Thornthwaite (1948), Gaussen (1959), Troll (1968) and others.

Holdridge's model divides the world into seven latitudinal regions (based on mean annual temperature at sea level). All of Ecuador falls into one of these regions – the tropical. The tropical region is divided into 37 life zones, of which 22 are found in the Ecuadorian Andes and the immediately adjacent lowlands. In addition, Ecuador has a wet high-elevation life zone, which falls outside the Holdridge classification system. Fortunately, this aberrant life zone is limited in extent.

The life zones are normally shown on a tri-axial diagram as hexagons (*Figure 7.1*), the boundaries of each being defined in terms of mean annual biotemperature (equivalent to elevation) and mean annual precipitation. The third axis of the diagram is determined by the other two; it represents the moisture regime, defined as a proportion between mean annual biotemperature and mean annual precipitation. Holdridge assumes that biotemperature is linearly related to potential evapotranspiration (which is not true for the Ecuadorian Andes; *see* discussion in the preceding section). The latitudinal regions and the altitudinal belts are defined in terms of mean annual biotemperature and not in terms of latitudinal degrees or meters of elevation.

To determine which life zone corresponds to a give site, the first step is to locate the point on the life zone chart that represents its mean annual precipitation and mean annual biotemperature. Generally, the point will fall within one of the hexagons. The name of the altitudinal belt associated with this hexagon, and the vegetation type name within the hexagon, are recorded.

The next step is to determine the latitudinal region in which the site occurs. This is done by converting the mean annual temperature at the site to a corresponding mean annual temperature and biotemperature at sea level, using the site elevation and a suitable temperature lapse rate for the area. This procedure, in essence, corrects for the different seasonalities encountered in different latitudinal regions.

The combined names of latitudinal region, altitudinal belt and vegetation type, in that order, provide the name of the life zone. For example, a site at 3000 m with a mean annual biotemperature of 8 °C and total annual rainfall of 2250 mm is the Tropical Montane Rain Forest Life Zone. Note that the "Tropical" modifier refers to the latitudinal region while the "Montane" modifier refers to elevation.

It should be noted that the latitudinal region and altitudinal belt bracketed by 12 °C and 24 °C are further divided by the "frost line" or critical temperature line into two parts: Warm Temperate–Subtropical and Premontane–Lower Montane, respectively. In this region or belt there is a very significant change in species composition due to the presence or absence of killing frost or near-freezing temperatures.