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Towards a Quantitative Classification of Soil Nutrient Regimes in British Columbia: Comparison of Regional Studies

Introduction

The three major components in the site classification of the biogeoclimatic ecosystem classification system are: climatic regimes, soil moisture regimes (SMRs) and soil nutrient regimes (SNRs). Both SMRs and SNRs can be identified in the field using soil characteristics and indicator plants. In the case of SMRs a quantitative classification was also developed that allow comparison of SMRs in different subzones. However, similar quantitative classification has not yet been developed for SNRs. This pamphlet summarizes and compares the results of several regional studies conducted in different biogeclimatic zones. Each of theses studies aimes to develop a quantitative SNR classification (Table 1). The comparison will examine: (1) how well the field-based classification matches quantitative classification, and (2) which direct measures distinguish best between field-identified SNRs.

Table 1. Summary of regional studies

	Study	Study stands	Zone
1	Kabzems (1985)	Douglas-fir	CWH
2	Klinka and Carter (1990)	Douglas-fir	CWH
3	Kayahara (1992)	Western hemlock	CWH
4	Klinka *et al.* (1994)	Lodgepole pine and interior spruce	SBS
5	Chen *et al.* (1998) (*Scientia Silvica* Number 22)	Subalpine fir and Engelmann spruce	ESSF
6	Splechtna unpublished data (*Scientia Silvica* Number 21)	Pacific silver fir	MH
7	Varga and Klinka unpublished data (*Scientia Silvica* Number 24)		CWH

Study Stands and Procedure

In each study stand SNR was identified using field-observable soil morphological properties and indicator plants and a composite sample was taken from the forest floor and 0-30 cm of the mineral soil. Site index of the study species was obtained from stem analysis. The composite samples were analyzed for the following nutrient properties: pH, total C (tC), total N (tN), mineralizable-N (min-N), and extractable Ca (eCa), Mg (eMg), K (eK) or their sum (SEB), P (eP), and S (eSO_4-S). All properties were expressed as concentration on a dry mass basis. To describe the quality of organic matter and N-availability, C:N ratio was calculated.

In most studies the stands were stratified into five SNRs by two methods: (1) using field estimates and (2) using direct measures of soil properties, and two classifications were compared by discriminant analysis. The relationship between these classifications and site index was evaluated by regression analysis.

Results

In all studies, the field-based and quantitative classifications provided very similar results: 60-70% of the plots were classified into the same SNR by both methods. In every study soil nutrient properties increased consistently from very poor to very rich SNRs. In general, N-related measures (min-N, tN and C:N ratio) had the largest differences between SNRs. In all studies, the single most important variable was min-N, which in some studies had strong relationships with tN. Most neighbouring SNRs could be distinguished based on the mean min-N values. Similarly, site index values showed strong relationships with both field-based and qualitative classifications in all studies. However, when the studies are combined SNRs cannot be differentiated based on min-N values because the min-N values for a given SNR in one study does not often agree with another study (Figure 1). In consequence, a given range of min-N values may comprise different SNRs in different zones.

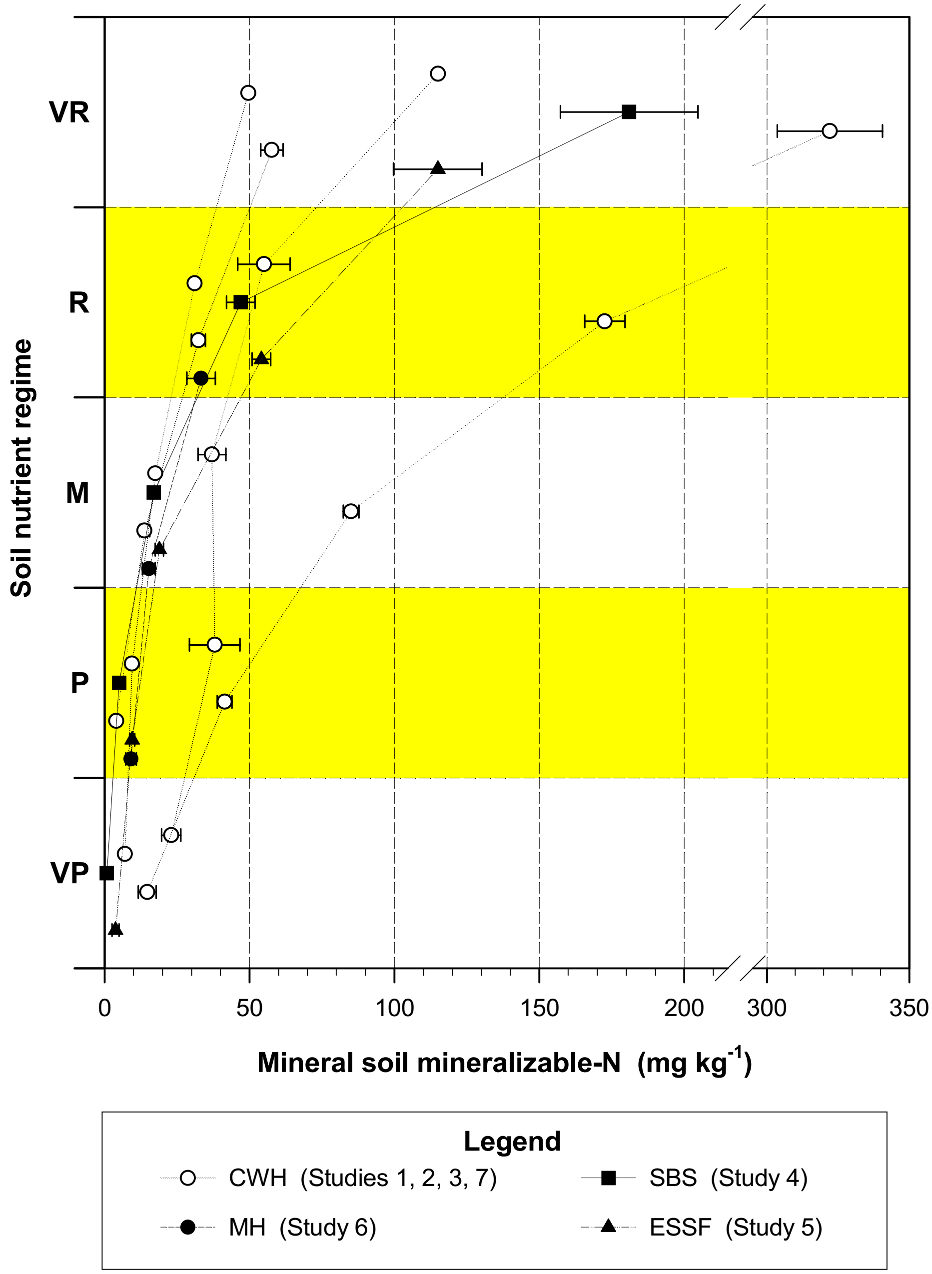

Figure 1. Comparison of mineral soil mineralizable-N values between regional studies in four zones. The symbols represent mean values and bars indicate the standard error of the mean.

Discussion

Although the studies under comparison were conducted in different climatic and soil environments, they showed similar results and trends. In general, field-based classification provided more consistent classes across different regions than quantitative classification. We concluded that in all regions N is the most important nutrient for characterizing a soil nutrient gradient and framing SNRs as well as for predicting forest productivity. Despite the fact that mineral soil min-N was the most significant and suitable differentiating characteristic, when all the studies were combined, min-N values were similar for some SNRs and had a wide range for some other SNRs (Figure 1). For example, the min-N values between 30 and 50 mg kg^{-1} included poor, medium, rich, and very rich SNRs. This was partly due to a high variation of min-N values in several studies conducted in the CWH zone, while only one study was conducted in each of the MH, ESSF, and SBS zones. This situation emphasizes importance of (1) having several studies within a zone and (2) selecting the study sites irrespective of tree species.

On the other hand, the min-N values determined for each of the five SNRs in the MH, ESSF, and SBS zones were quite similar, suggesting that SNRs in these three zones could be separated by common min-N values. As these zones are considerably different in their climate and soils, it is reasonable to assume the between-zone variation is less than within-zone variation. This means that the field identified SNR would have more or less the same value in each of these three zones.

Keeping in mind the development of an absolute or zone-independent classification based on mineral soil min-N, we suggest there are two possible approaches - either to recognize more than five SNRs or to continue using five SNRs. For both approaches arbitrary limits of min-N values have to be established for each SNR. Using five SNR classes, the arbitrary limits might be <10 for very poor SNR, 11 - 30 for poor SNR, 31 - 70 for medium SNR, 71 - 150 for rich SNR, and >150 for very rich SNR. In addition, both approaches would require revision of the key to identification of SNRs in the field.

Conclusions

The comparison of regional studies showed similar results and trends for different climatic and soil environments, and demonstrated that for some zones field-based and quantitative classifications are zone-independent. The most promising way to develop a quantitative support for field-identified SNRs across the province is (1) to continue using N related measures for characterization of a soil nutrient gradient, (2) to replicate studies in some zones, (3) to expand regional studies to the IDF and ICH zones, and (4) to impose arbitrary limits on five SNRs accompanied by revision of field-keys.

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