Review Article

RECENT TRENDS IN SITE QUALITY EVALUATION

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ABSTRACT

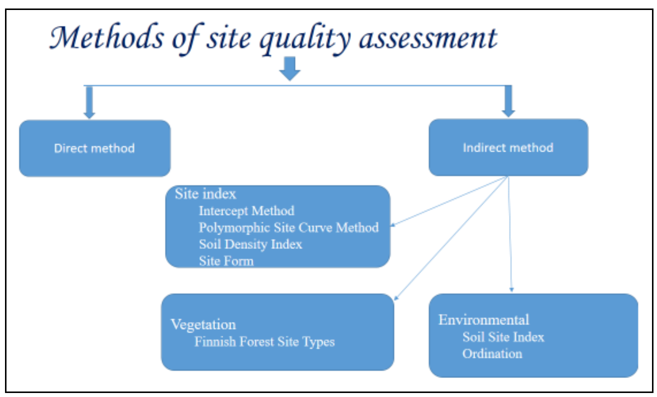
Site quality (SQ) is maximum timber a site can produce in a given year. Site quality evaluation is important tool for plantation management. Site factors decide the productivity of that site which varies with species. Though there are many direct and indirect methods for site quality evaluation, having their own advantages and limitations. Site index is most commonly and widely used in even aged forest. Intercept method has been used to determine site quality of young stands. For mixed and uneven-aged forests where determination of the age is quite subjective due to false annual growth site form method is used. RSI is new method of site quality evaluation based on self-thinning law. Site quality classification based on vegetational approach is found suitable in low latitudes. As productivity mainly derived by climate and soil environmental approach is also used. All the methods examined are reasonably accurate if applied to restricted areas. A carefully derived SI is the most accurate indirect method of SQ measurement. In this paper we will discuss various method for site quality measurement.

INTRODUCTION

Site productivity assessment is a major need for sustainable plantation and forest management. Reliable evaluation of site quality is important for improved predictions of timber yields and for meaningful simulation studies. Site quality is the inherent capacity of site to be producing certain amount of timber. Site quality can influences species composition through competition, response to disturbances, the ease or difficulty of getting desired regeneration cultural practices. Success or failure of plantation management depends, to a large extent, on correct evaluation of forest sites and choice of species suitable sites (Smith, 1956). Site factor decides quantity and quality of timber production per unit area. Site quality is productive potential of site, maximum timber crop a land can produce in a given time for given species. SQ evaluation is pre-requisite for taking any silvicultural decision. SQ gives idea about the kind and magnitude of problems and opportunities in a managed stand. SQ is limited by factor which is less than optimum or excessive, reduces soil quality. SQ is true measure of site but difficult to assess. Foresters need site-specific information on site quality to make proper decisions about species selection and management practices.

METHODOLOGY

The information has been collected from the secondary sources and the review of research has been done, various published research papers, thesis, abstracts and reviews were searched from Google scholars, Research Gate, PUBMED, Krishikosh and Shodhganga.



DIRECT METHODS

It is precise method to grow a fully stocked stand of the desired spp. on a site for designated period. Each plot, every tree above a specified minimum diameter at BH was measured for diameter and height. Optimum stocking is better than full stocking. Full canopy of normally developed crowns could include small holes (Myers, 1966). The volume of timber and the many stand values that constitute a normal yield table were then calculated from this data. Data provide- growth and development of a stand. The relationship establishes the principles of stand development as affected by site quality.

Disadvantages

- ✓ It is costly and time consuming.
- ✓ Full stocked not present naturally
- ✓ Yield table's gives only average yield not maximum.
- ✓ Logging carried out in better stand- data misleading.

INDIRECT METHODS

Site Index Method

This method uses top height as a measure of site quality, mean height of upper crown class trees that have been free to grow in an even-aged stand at a specified index age. To accurately assess site index in stands that are uneven aged, mixed specie is difficult. The rate of height growth is the most practical, consistent, reliable and useful indicator of site quality with respect to timber production. Site index in terms of the average height of the dominants, the largest, full-crowned trees in a stand in a given a year. Site index of 20 on a 25-year base means that the dominant trees will have average 20m total height at 25 years of age. This is most practical, quick easily used for mixed stand also, but having some drawbacks as height may influence by density and competition, differential height growth in provenances within species. And form of growth is not same for all sites. Site index (SI) is an important tool in forest management and planning as it is strongly correlated to other variables, the potential of a site to produce timber (Vanclay, 1992). However, obtaining an accurate SI for a young stand is often difficult.

Intercept Method

SI curve developed for mature natural stands may underestimate or overestimate the site productivity if used in a young plantation simply because the SI curve is not calibrated for young plantations which may result in inaccurate stand prescriptions for plantations. Thus Intercept method has been globally used to determine site quality of young conifers, too young for the conventional method of evaluating site quality, by recording age and top height, and avoids the necessity of using different age classes while assessing the site quality of any conifer forest. They are particularly useful in obtaining an accurate SI for juvenile stands of less than 20 years old. It estimate SI from the mean annual height growth immediately above breast height. Typically, height growth is identified from annual branch whorls and is averaged over a 5 year period. It is most feasible for conifer species having obvious annual branch whorls such as red pine. This quick and easy method use measurement above breast height which eliminates many of the establishment period variability. However in jack pine, annual branch whorls are less obvious making this method error prone. The height intercept method offers a direct measurement of site quality and enables early evaluation of site quality until they become old enough for evaluation by conventional site index method.Though the total length of the first five annual internodes above DBH is reliable but diameter at 8 feet gives double accuracy. It have advantages in crowded young stands or closed stands as knowledge of the age of the stand is not required and height age relationship is obscured by hazards before attaining breast height but affected by short term climatic conditions. Dalai *et al.* (2000) showed that out of all the height intercepts, the 6-y height intercept showed the best result and hence was used for categorisation of sites for their site quality was to classify the young chir pine plantations of age 19 years for their site qualities using the height intercept method. A similar classification for site quality differentiation has been given by Mohns *et al*. (1988) for Chir pine in Nepal, and Sahu (1997) and Dalai *et al.* (1997) in Himachal Pradesh, India.

Polymorphic Site Curve Method

Site index in these curves is expressed as total tree height at a specified index age. For most eastern forest species site index is commonly defined as total height at a total age of 50 years; breast-height (1.3 m) age is commonly used for species having slow and erratic height growth below breast height. Most of the older site index curves are anamorphic curves based on harmonizing methods but most recent site index curves use stem-analysis data, breast-height age and nonlinear regression models capable of expressing polymorphic height-growth patterns (Carmean *et al*., 1989).

- ✓ Based on intercept, represents growth for 10 yr after certain height.
- ✓ Growth rate at upper portion of height growth curve better represent soil quality.
- ✓ Site rated according to increment of dominant of standard height.
- ✓ Used for forest where early suppression prevalent.

Site Form Method

Several problems like false annual growth rings, disparity response of this index to climatic factors and the dependence of site index on forest density make determination the age quite subjective (Bontemps and Bouriaud, 2014). This method is used in mixed and uneven-aged forests where determination of the age is quite subjective due to false annual growth. The height at a specified diameter was used as a measure of site quality and was called as site form. The height at a specified diameter was used as a measure of site quality and was called as site form. Generally height at 75 cm DBH is used. Site form is considered as good measures of site productivity as site form are reproducible and consistent over long periods better indicative of site and not affected by stand condition or management history, well correlated with the site's productive potential, simple to measure and avoid necessity of data from permanent plots (Vanclay and Henry, 1988). Relationship between tree height and diameter at breast height (DBH) in a stand is the most sensitive and reliable measure of site quality (McLintock and Bickford, 1957).

RELATIVE STOCKING INDEX

It is defined by Berguson *et al.* (1993) as an alternative index of site quality, the relative stocking index (RSI). RSI is the ratio of a stand's measured density to that predicted using the log-log relationship and thinning line and. RSI is easy to apply, robust (resistant to change), and Related stem density & power law of self-thinning.RSI is a measure of resources available for trees, High RSI means tree on site requires less area than poorer site and more resources per unit area are available on the better site. It can be used for multiple aged & mixed stand also.

As SI is difficult to evaluate in multispecies, multiple-aged stands (Bergusan *et al.*, 1994), therefore explored alternative definitions of site quality, such as "productivity" classes based on both site index and stand basal area and a productivity index based on soil. While site quality as assessed by site index is based on tree height, the RSI is based on stand stocking or stem density, and is related to the power law of self-thinning (Westoby, 1984). There has been long-standing recognition of differences in yield within site-quality classes defined by tree height growth for example, states that "yield from one and the same site quality class exhibits considerable variation which depends on site factors such as nutrient content of the soil and its moisture conditions. On a functional basis, RSI is a measure of resources available for trees. The RSI is based on the number of trees per unit area, and its inverse is the area of land per tree. A high RSI implies that each tree on that site requires less area than does a similar-size tree on a poorer site. The RSI for each stand was calculated as the ratio of its measured density to that predicted for its cover type from the norms. Stands with higher measured than predicted density had indices > l, while those with lower measured density had indices < l. Indices were based on arithmetic, not logarithmic values.

VEGETATIONAL APPROACH

Certain plants occur in reasonable definite local environment, there is as correlation with environment with plan cover. It can draw conclusions about the environment from the plant cover. This concept Originated from successful study of pioneer in Finland by Cajander in 1926. In cold latitude due to narrow ecological amplitudes this hold true but in warm latitudes due to wide ecological amplitudes it is difficult. The presence of certain climax spp. indicated site quality as certain species are consistently present in association with a certain site quality and lacking on any other site called as indicator plants.

Finnish Forest Types

Cajander was first to classify relation between plant cover and site productivity in Finland in 1926. It's an assumption that certain climax species in cover are consistently present in association with mature stand representing site quality. Indicator plants are used to classify land site quality. But this method also criticised for change in ground cover due to change in over story. This method is working well in northern Finland but not relevant in southern part as having more diversity and richness. Cajander tried to classify based on productivity with help of indicator plants on upland soil within different region of Finland (Table 1).

Table 1: Forest site types classified by Cajander (1926)

General Site Characteristics	Site	South Finland	Central Finland	North Finland
Driest and most barren, upland site, usually coarse sand	V	*Cladina* type	*Cladina* type	*Cladin*a type
Moderately dry site, sandy to morainic soil	III	Vaccinium type	*Empetrum-Vaccinium* type	*Myrtillus-Myrtillus* type
Most fertile, upland soil with more humus	I	*Oxalis-Myrtillus* type	*Geranium-Oxalis Myrtillus* type	*Geranium- Myrtillus* type

ENVIRONMENTAL APPROACH

Maximum production and good quality of wood at smallest cost can be attaining by growing tree in best suited climate and soil of locality. In general major forest association will be found to coincide with soils. Inability of indicator plants to provide reasonable correlation with productivity led explore to locally significant physical in an environment (Daniel *et al.*, 1979).

Soil Site Index

Soil quality within given microclimate is associated with soils capacity provide moisture and nutrient. Many researcher has develop relationship between site index and soil variables such as parent material, profile, slope aspect, moisture etc. The estimate of site index based on soil and site factors have been able to account for only 50 to 60% of the total variation (Covell and McClurkin, 1967).

Ordination Method

It is the method of investigating the response of vegetation to environmental factors and factors to be considered as continuum. Smooth Transition from hot to cold opposite to earlier classification (discrete). It may be in one directional or multidimensional order (Daniel *et al.*, 1979).

CONCLUSION

SQ evaluations are essential for decision making in the management of any forest and plantation. SQ evaluation depends on accuracy of correlation with SI values. For SI Top height is better than Diameter as it have negligible pseudo-growth. All the methods examined are reasonably accurate if applied to restricted areas. A carefully derived SI is the most accurate indirect method of SQ measurement. Density and suppressions can often influence a site index rating, while vegetation and environmental approaches are free of these influences. Use of fertilizers & short rotation forestry alter past site quality evaluation and should be revised.

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