

SOIL SURVEY AND FOREST MANAGEMENT.

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It is proposed to consider briefly soil survey in relation to forest management and more particularly to consider the intensity of survey commensurate with probable and practicable intensity of forest management in New Zealand.

Sound forest management has as its basic concept the principle of sustained yield. In a virgin forest the existing plant growth is an expression of the site factors, mechanical factors such as those of climate, topography, soil and subsoil, and biotic factors (such as the inter-relation between plants and the soil micro-flora and fauna, indigenous grazing animals, etc.). So long as there are no significant changes in the site factors the forest will remain in a state of equilibrium with its environment, and a sustained yield is possible.

Of the mechanical site factors the only one to be influenced significantly by man's activities is the soil factor. From a forestry point of view these activities may result in the improvement, the maintenance, or the deterioration of the soil quality. On the one hand soil improvement would result from the establishment of a permanent forest cover on an area of shifting sand, for instance, while on the other hand soil deterioration would result from removal of the forest cover followed by frequent burning over a period of years.

Trees and other plants that have roots which penetrate the soil, obtain from it nutrient materials essential for their well-being. The soil provides the trees with space for root growth and development. It not only furnishes the physical support for the tree but it provides also the water used on its various life processes. The seed germinates in or on the soil. The roots push their way between the soil particles absorbing water and nutrients needed by the tree. It is obvious that, if the soil is of such a character that the roots cannot grow in it, or if the tree cannot find therein an adequate supply of the needed nutrients, tree life cannot exist at all.

While climate is altogether the most important influence in determining the range of a species, the character and condition of the soil often are responsible for its limitation. Deficiency in precipitation may result in a soil becoming too dry for a given species. The unfavourable physical condition of a soil may prevent tree reproduction. Inasmuch as the soil provides the water and nutrients for the tree, there is scarcely a physiological process that is not controlled by it or a silvical characteristic that is not dependent upon it. Rate of growth, duration of life, form, quality of wood, tolerance, reproduction and yield are all influenced and modified in one direction or another by the soil.

Thus, intensive forest management is connected intimately with the accurate assessment of soil quality. The uses of soil survey are twofold :—

- (1) In the assessment of site factors prior to the establishment of a new species, and
- (2) For the examination of the site during the first rotation or in a subsequent rotation to determine the influence of a particular species, length of rotation, or other silvicultural treatment on the soil quality.

Of these, the first mentioned is the one of chief interest at the present stage of forest management in this country. From a soil survey a forester requires to know:—

- (a) Generally whether the soil is suitable for tree growth.
- (b) More particularly the special characteristics of the soil which would favour one species or another.
- (c) What areas are unsuited to tree growth completely, or from the point of view of economics.

How detailed and specific should be this information? For the sake of argument, visualise a level or gently sloping acre of rich river flat. The soil has depth, porosity, abundant moisture and organic matter, a quality I site. But upon this acre are boulders, partly submerged in the soil, distributed at random and covering in the aggregate 50% of the area. From the forester's point of view it is unnecessary to show these boulders on a detailed plan; they are visible and the plantable spots can be seen. Now visualise these selfsame boulders covered with 4 inches of soil and the problem becomes very different. A general survey of the acre would indicate that from a soil point of view it was a Quality I site with small unplantable spots distributed at random throughout. The unplantable spots still total 50% of the area, but they can now be located only by a detailed soil survey, during which, to be of real assistance to the forester, the position of each boulder would need to be marked by a pole.

This example is directly comparable with the position on many of our clay and clay loam soils. Ordinarily the watertable follows the contours of the ground though in a less accentuated manner. The depth at which it is encountered increases as the sides of the valley or hill are ascended. Complications are produced by impervious strata so that in some cases the watertable may be quite near the surface in elevated situations. This is still further complicated by the fact that clay soils on undulating to hilly country slip frequently and the familiar, hummocky, landslip topography results, accompanied by a complete change in the profile of the water-table. Pockets and ledges of poorly drained soil occur, comparable with the concealed boulders in the preceding example. Sometimes their presence is suggested by the nature of the surface vegetation, but more often they could be located accurately only by a detailed soil survey,

during which, as previously stated, to be of real assistance to the forester, the position of each poorly drained pocket would need to be indicated by a pole.

Even under intensive silviculture it seems unlikely that differential treatment on these small pockets would be feasible. The problem would resolve itself into whether to plant up the whole area, leaving it to the trees to find out the poor spots, or, alternatively, to leave the area unplanted.

I contend that a general survey of the soils on the different topographic types, ridge top, plateau, hillside, or valley bottom, accompanied by an examination of the surface vegetation, is all that is practicable and will give the forester information which is practicable to act upon.

This general survey should cover the following :—

- (1) General topography.
- (2) Nature of plant covering.
- (3) Litter. Depth.
- (4) Humus. Depth and character.
 - (a) Mull. A more or less friable humus layer only very slightly matted and merging into the mineral soil.
 - (b) Duff. A layer of unincorporated humus, strongly matted or compacted and with a clear line of demarcation from the mineral soil.
- (5) Mineral soil.
 - (a) Texture. Sand, Loam, Silt, Clay, Peat and intermediates. Based on appearance and "feel."
 - (b) Colour.
 - (c) Compactness. Very compact :—A spade will not enter.
Compact :—A spade enters with difficulty.
Loose :—A spade enters easily. A sod breaks up readily.
Crumbling :—The soil particles are not coherent.
 - (d) Moisture. (Based on appearance and "feel.")
Wet. Water drips from soil.
Moist. Water drips from soil when pressed.
Fresh. No water drips from soil when pressed but colour shows its presence.
Dry. Little or no trace of moisture. Does not turn to dust when rubbed.
Arid. Turns to dust when rubbed.
 - (e) Drainage.
Free drainage.
Impeded drainage.
 - (f) Unweathered or partly weathered substances.
Character (gravel, stones, boulders, etc.).
Frequency (few, frequent, or dominant).

- (g) Depth of root penetration.
- (h) Distance of subsoil below surface.
- (i) Nature of underlying rock.
- (j) Any unusual features, such as presence of a "pan."

All of this information can be obtained in the field from a general examination and from a series of auger borings judiciously made. A 4 foot auger, of 1 inch or 1½ inch diameter, with the ½ inch point cut off, makes a satisfactory instrument.

The fact that the majority of our forests, both existing and projected, are distant from substantial markets precludes the practice of any great intensity of forest management and the yield must of necessity be confined to final thinnings and final crop trees.

Should the population of this country be trebled, intensity of forest management could be raised to a correspondingly higher level, calling for closer adaptation of species to site and the planting of species in mixtures, all of which would necessitate a more complete evaluation of the site factors, a more complete and detailed soil survey.

Until that time arrives it is considered that a soil survey carried out on the lines indicated above would place the achievement of the present objectives on a reasonably sound basis.