Chapter-4

MATERIALS

AND

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The present investigation entitled “Study the impact of forest fire on ecosystem of *Pinus wallichiana* (A.B. Jackson) in temperate forests of South Kashmir” was conducted at South Circle of Kashmir forest division and laboratory analysis was done in Department of Soil Science, Forest Research Institute, Dehradun, Uttarakhand during the years 2011-2013. The chapter provides insights into how the study was conducted, experimental sites, materials used and methodology adopted during the course of study period. The research design adopted, methods of data collection, sampling and means to draw necessary conclusions have been highlighted.

4. Experiment Methodology

4.1. Selection of the site: The selection of the study sites was done on the basis of data available with the forest department about the occurrence of forest fires in *Pinus wallichiana* forests for the study purpose. Ten sites were randomly selected in Anantnag, Lidder and Kulgam forest divisions. The study sites are located between 33°28' - 34°04' N latitude and 75°05' - 75°17' E longitude in South Kashmir region of Jammu and Kashmir. In each site, it was assumed that there was a uniform environmental condition but environmental conditions could vary among the sites. The different sites chosen in the given study are characterized by different climatic, edaphic and physiographic conditions. Besides these different sites are subjected to different levels of biotic interference owing to their location and accessibility and the economy of fringe village population. Moreover these forest sites fall in different forest divisions and have been managed historically under different set of management practices as per their working plans. Finally the data on forest fire acquired from the working plans and other ancillary information provided by the State Forest Department J&K reveals that there has been variability in the frequency and intensity of forest fires at different forest sites which makes each site condition different from one another. Thus, the sites are a factor in themselves as they represent different conditions for incidences of forest fires. Vegetation data was collected in burnt and unburnt blue pine forests by laying out ten randomly distributed quadrats (in each burnt and unburnt sites) of 10 m x 10 m for enumeration of trees and within it, 5 m x 5 m for shrubs + saplings and 1 m x 1
m for herbs + seedlings as method suggested by Mishra (1968). The phytosociological parameters were studied from the basic data: Listing of all plant species (trees, shrubs and herbs), Density, Basal area, Frequency, Abundance, Importance Value Index (IVI), Shannon Wiener Index (H)” and Species Richness Index (R).

**Density (D):** It represents the numerical strength of the species in a community and was calculated as per Curtis and McIntosh (1950):

\[
\text{Density } D = \frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}
\]

**Basal area:** Basal area is the area of ground actually penetrated by the stems, and is readily seen when the leaves and stems are clipped at the ground surface (Hanson and Churchill, 1961). Basal area was calculated as:

\[
\text{Basal area} = \pi r^2 = \frac{\pi d^2}{4} \text{ or } \frac{g^2}{4}
\]

Where d is the diameter at breast height and g is the girth at breast height.

**Frequency (F):** Frequency indicates the number of quadrat in which a given species occurs (Raunkiaer, 1934). Frequency was calculated as follows:

\[
\text{Frequency (F)} = \frac{\text{Number of quadrats in which the species occurs}}{\text{Number of quadrats studied}} \times 100
\]

**Abundance (A):** The abundance and density represent the numerical strength of species in the community (Mishra, 1968). Abundance is described as the number of individuals occurring per sampling unit and density as the number of individuals per sampling unit. Abundance was calculated as follows:

\[
\text{Abundance (A)} = \frac{\text{Total number of individuals}}{\text{Number of sampling units of occurrence}}
\]
**Importance value index (IVI):** The Importance Value Index (IVI), which is an integrated measure of the relative frequency, relative density, and relative basal area and was calculated from the basic data for each species of trees, shrubs and herbs (Phillips, 1959).

\[
\text{Relative basal area } RBA = \frac{\text{Total basal area of species}}{\text{Total basal area of all species}} \times 100
\]

\[
\text{Relative density } RD = \frac{\text{Number of individuals of species}}{\text{Total number of individuals of all species}} \times 100
\]

\[
\text{Relative Frequency } RF = \frac{\text{Number of occurrence of species}}{\text{Total number of occurrence of all species}} \times 100
\]

\[
\text{IVI} = \text{Relative basal area (RBA)} + \text{Relative density (RD)} + \text{Relative frequency (RF)}
\]

**4.2 Shannon Wiener Index of general diversity (H):** Species diversity consists of two components, the species richness and the relative abundance (evenness or unevenness) of species within the sample or community. The data collected from the quadrat was analyzed for the estimation of Shannon’s diversity indices. Shannon’s Index (H’) (Shannon and Wiener, 1963) is one measure of species diversity that takes into account for each species, the proportion of individuals that contribute to the total sample. It was calculated from the importance values using the formula:

\[
H' = - \sum_{i=1}^{s} p_i \ln p_i
\]

Where, H’ is Shannon-Wiener Index of species diversity, \( p_i \) is the proportion of \( i^{th} \) species and \( s \) is the number of individuals of all the species.

**4.3 Margalef Richness Index (R):** Species richness is defined as the number of species for specified number of individuals. Species richness measures have great intuitive appeal and avoid many pitfalls, which can be encountered when models or indices are employed. A number of simple indices have been derived using some combination of total number of species and total
number of individuals summed over all the species. Here, richness was calculated using the formula (Margalef, 1958):

\[ R = \frac{S - 1}{\ln N} \]

Where, \( S \) is the total number of species and \( N \) is the total number of individuals from all the species.

4.4 Soil characteristics
Combustion of the debris left on the surface after the cutting and cleaning operation not only burns the organic matter but also heats up the surface soil and affects the soil aggregation.

4.4.1. Soil Analysis
4.4.1.1. Soil sample collection
The soil samples were collected in bags from different elevations for better representation of a composite sample at all the selected sites. The soil samples were collected from burnt and un-burnt plots from the depths of 0-15 cm and 15-30 cm. The soils of two depths were mixed to make one representative sample. The fresh and oven dried weights of soil samples were recorded and the samples were used for soil analysis.

4.4.1.2. Soil physico-chemical properties
Soil samples were analyzed in laboratory for different physico-chemical properties:

4.4.1.2.1. Per cent soil moisture: It was determined by weighing a soil sample before and after oven-drying (Black, 1965). This is called the gravimetric method, which is the direct measurement of soil water content. The water loss is divided by the oven-dry weight to obtain per cent moisture. It was obtained by using the formula:

\[ \text{Per cent moisture} = \frac{\text{Weight of moist soil} - \text{oven dry weight}}{\text{oven dry weight}} \times 100 \]
4.4.1.2.2. Bulk density ($D_b$): It can be defined as the dry weight of soil per unit volume of soil. It was determined by core sampler method (Black, 1965). Soil porosity was estimated by Imbibition method.

\[
D_b = \frac{\text{mass of dry soil (mg)}}{\text{volume of solids and pore space (cm)}^3}
\]

4.4.1.2.3. Soil pH: It was determined by 1:2.5 water suspensions method (Jackson, 1967).

4.4.1.2.4. Organic carbon and Organic matter: It was determined by wet digestion method of Walkey and Black (1954). 0.50 – 2 g of air dried soil was taken in a 500 ml conical flask and 10 ml of NK$_2$Cr$_2$O$_7$ solution was added followed by 20 ml of concentrated H$_2$SO$_4$. The flask was shaken by hand for 1 minute and allowed to stand for 30 minutes on an asbestos sheet. Then 200 ml of water, 10 ml of phosphoric acid and 1 ml of Diphenylamine indicator solution were added. The contents of the flask were titrated against 0.5N FeSO$_4$ solution. The end point was recognized when the blue color of the solution flashes to green within one drop of the FeSO$_4$ solution. A blank titration was run simultaneously. Percent organic carbon was estimated and analyzed. Also soil Organic matter was calculated by multiplying the soil Organic carbon with a factor of 2.5 (Broadbent, 1953).

**Calculation:** 1 ml of NK$_2$Cr$_2$O$_7$ is equivalent to 0.003 g of C. The % of C in the sample is given by the expression: 

\[
\text{% of C} = \frac{(V1 - V2 / W) \times (0.003 \times 100)}{W}
\]

Where 

- $V1$ = value of NK$_2$Cr$_2$O$_7$ (10 ml), 
- $V2$ = value of N FeSO$_4$ (or half value of 0.5 N FeSO$_4$ used) and 
- $W$ = weight of soil taken

4.4.1.2.5. Available Nitrogen: The available nitrogen present in the soil was estimated by alkaline permanganate method suggested by Subbiah and Asija (1956). 20.00 gm of soil was taken in the distillation flask and moistened with 20.00 ml of distilled water. After that, 100.00 ml of prepared 0.32% potassium permanganate solution and 2.5 % sodium hydroxide were added.
and distillation was done by collecting the distillate in 20.00 ml sulphuric acid (with methyl red as an indicator) in a beaker. After the distillation was ended, the contents of the beaker were titrated against 0.1N potassium hydroxide until a straw yellow color was obtained. From the difference in the titer value the amount of available nitrogen was calculated.

4.4.1.2.6. Available Phosphorus: The available phosphorus content present in the soil was determined by method of Olsen et al. (1954), using sodium bicarbonate as extractant. 5g of soil was weighed and transferred to a beaker and added with 25.00 ml of Olsen’s reagent (0.042 percent solution of NaHCO₃) and 1.00 g of activated charcoal. The contents were shaken in a mechanical shaker for 30 minutes and filtered through Whitman No.1 filter paper. 5ml of the filtrate was pipette out into a 25.0 ml volumetric flask. 1 ml of molybdate reagent and 1.0 ml of stannous chloride solution were added and the volume was made up. The colour developed was measured in a spectronic 20 calorimeter at 660 nm. A standard graph was prepared using KH₂PO₄ and the calculation of phosphorus was calculated.

4.4.1.2.7. Exchangeable Potassium

The available potassium content of the soil was estimated by the method described by Blakemore et al (1987) using ammonium acetate as extractant and 5 gm of soil was added. The contents were shaken for 5 minutes in a mechanical shaker and filtered by using a Whitman No. 1 filter paper. The filtrate was used to estimate the potassium content by using flame photometer. A standard graph was prepared with potassium chloride and the concentration of potassium was recorded.

4.5. Statistical analysis

To check the significant difference between burnt and unburnt categories of the parameters basal area and density under vegetation study, the t-test at 5% level of significance was used. Factorial Randomized Block Design having two factors as categories (burnt & un-burnt) and sites (10 sites) with 5 replications was used for analysis of collected data pertaining to soil characters using the SPSS software version 14.0. The main effects and interaction of the factors under the said design were checked at 5 % level of significance. Critical difference for main effects and interactions were calculated to compare the difference at the same level of significance.
4.6. Socio-economic relationship between villagers and forest department:

The relationship between forest department and socio-economic conditions of the villagers was determined by conducting socio-economic analysis of the villagers located nearby forest areas of each site which are dependent on forest resources for their day to day requirements. The socio-economic structure was studied due to impact of forest fires on fringed villages. The participation of villagers in protection and improvement of forests was also studied. The household questionnaire was prepared and 10-50% sampling was carried out depending upon total population size of the village (Appendix 1). The households from each village near to study site were interviewed and the data collected from the villagers was compiled and analyzed.