

Population age structure shows *Pinus wallichiana* regeneration surge in the static treeline in Manang, Nepal

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Introduction

- Treeline: The transitional ecotone between closed sub-alpine forest and alpine shrub land.
- Heat deficiency is the main controlling factor for plant growth dynamics in the temperature sensitive ecotone. Interactions of ecophysiological traits and biophysical conditions like moisture, slope, micro-topography, edaphic conditions also shape the treeline phenomenon. So, changes in these factors can bring marked influence in the plant growth, regeneration, population and community dynamics.
- The Himalaya is experiencing higher than global average warming rate.
- Understanding the changes in historical and current structural and population dynamics across the treeline ecotone provides insights into future direction of forest productivity and range dynamics.

Objectives:

- To analyze the age and size structure of *Pinus wallichiana* to assess regeneration across the treeline ecotone.
- To quantify the survivorship and mortality rate to estimate future direction of the forest growth.

Study Area

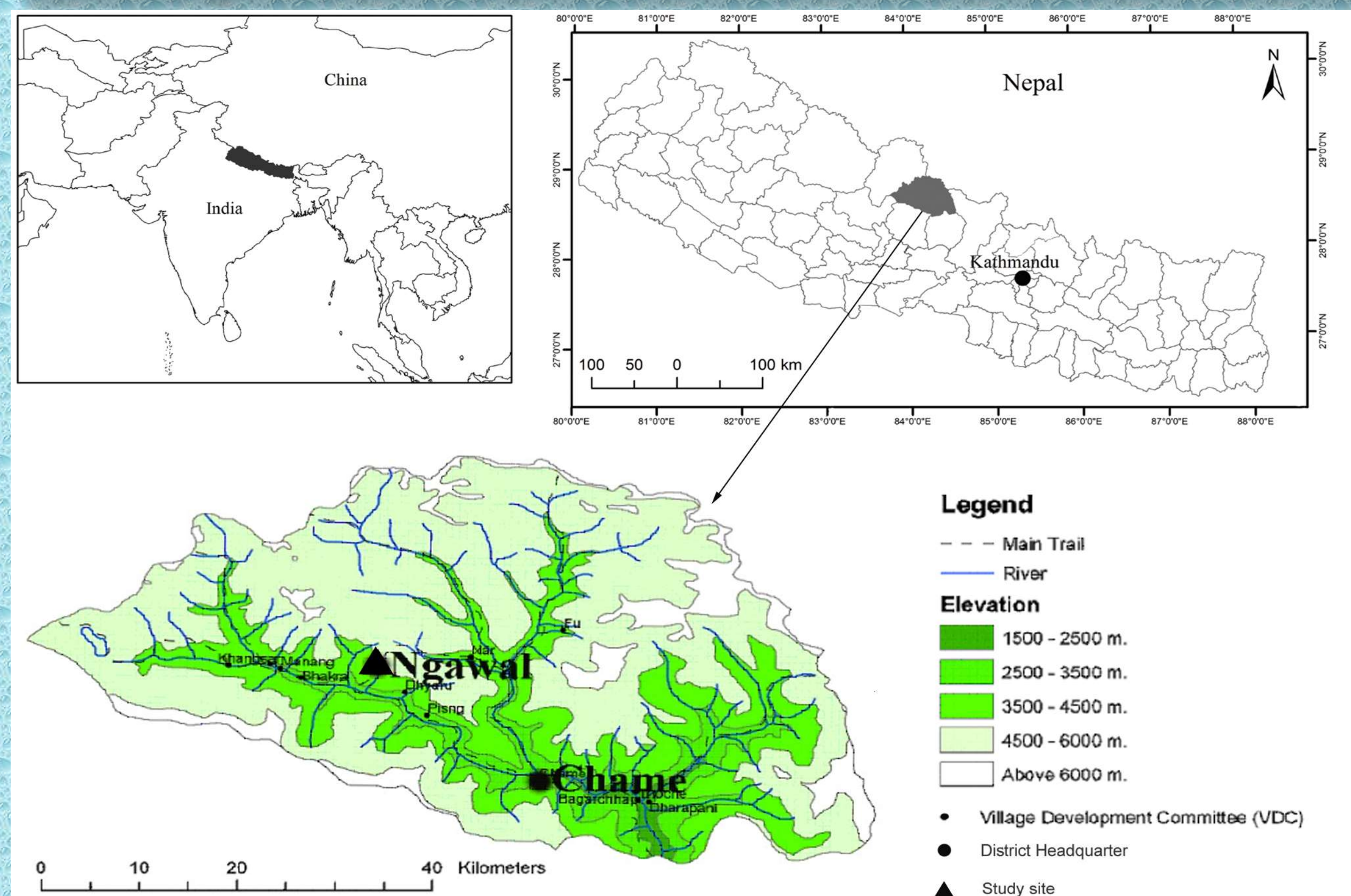


Figure 1: Study area

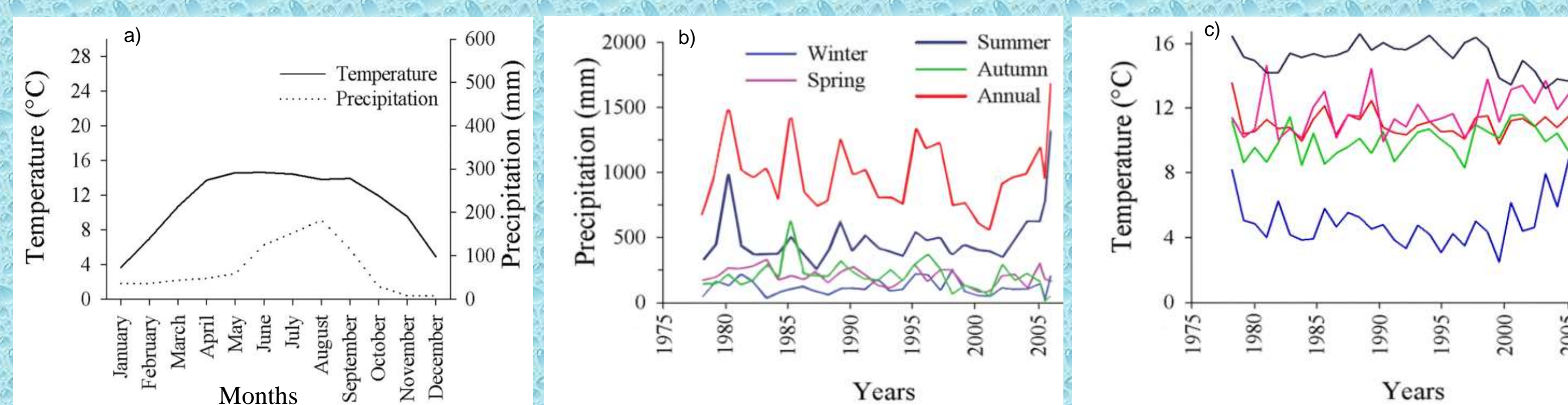


Figure 2: Climograph of Chame. a) Average monthly Temperature and Precipitation, b) Annual and seasonal precipitation, c) Annual and seasonal temperature

Methods



Figure 3: a) Studied treeline ecotone, b) Seedling observation, c) Extracting an increment core from a tree

Sampling Design

- Pine individuals were sampled from three vertical transects (20 m width) across the ecotone (from forestline at about 3910 m asl. to treeline at ca. 4020 m asl.).
- Along with the records of biometric measurements, trees were cored at the base and branch whorl/bud scars in seedling/saplings were counted for age estimation of individuals.

Results

Elevation Range (m asl.)	Tree	Sapling	Seedling	Total
3910 to 3940	34.44	18.88	7.77	61.09
3941 to 3970	40	22.22	4.44	66.66
3971 to 4000	11.11	14.44	2.22	27.77
4001 to 4020	8.88	7.77	1.11	17.76
Total	94.43	63.31	15.54	173.28

Table 1: *Pinus wallichiana* population in the treeline ecotone (individuals per hectare)

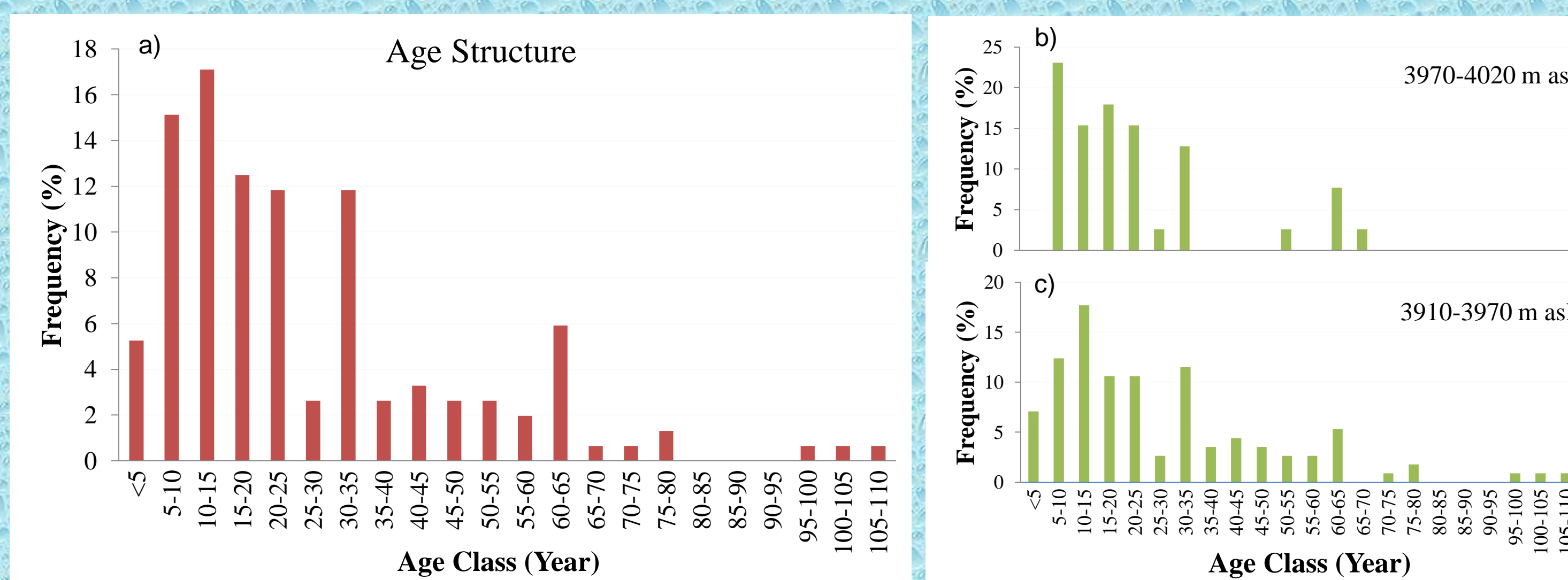


Figure 4: Age Structure; a) Age distribution over the treeline, b) Age distribution in upper half and c) Age distribution in lower half of the ecotone

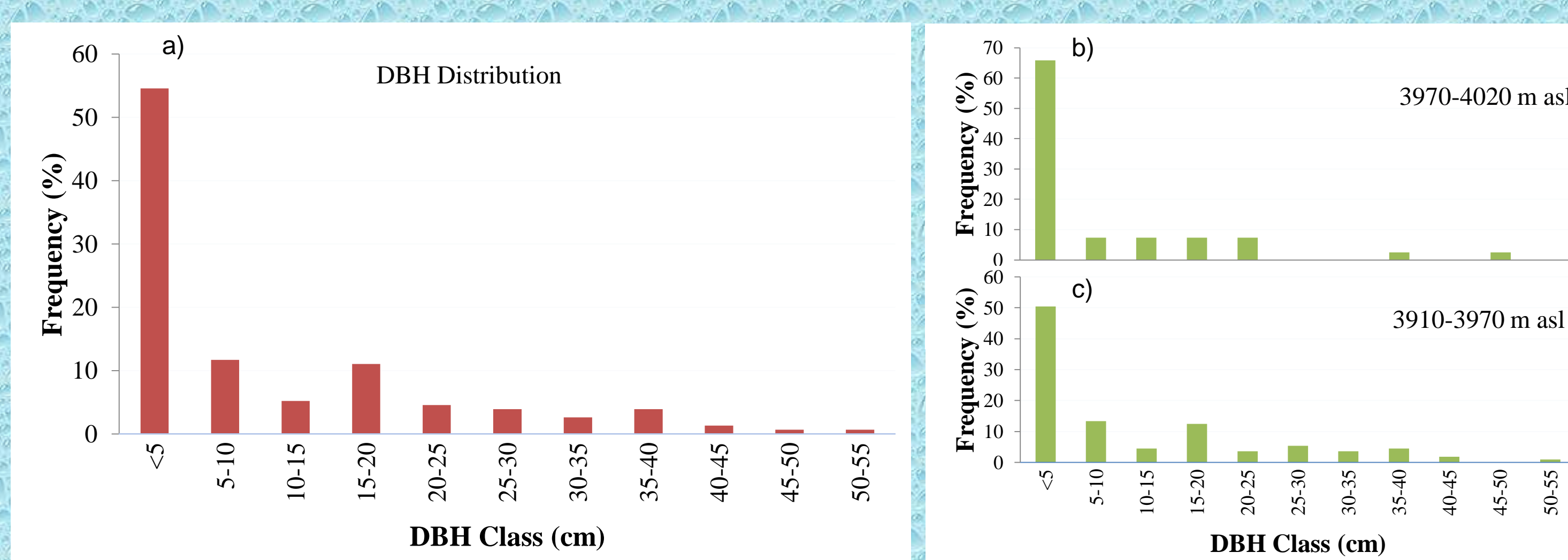


Figure 5: Size (DBH) Structure; a) Distribution over the ecotone, b) Distribution in upper half and c) Distribution in lower half of the ecotone

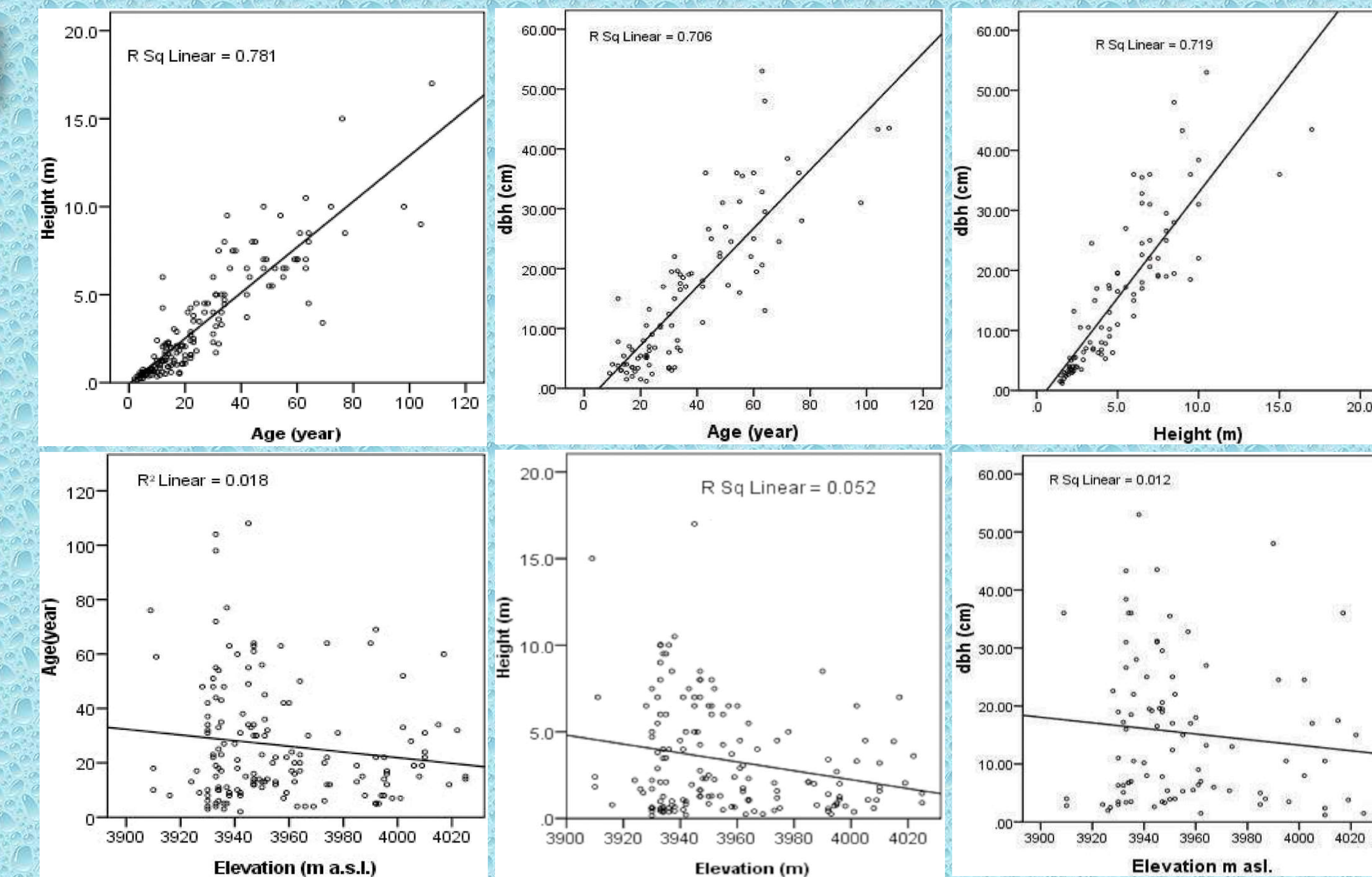


Figure 6: Age, Height and DBH relationships and their distribution along elevation

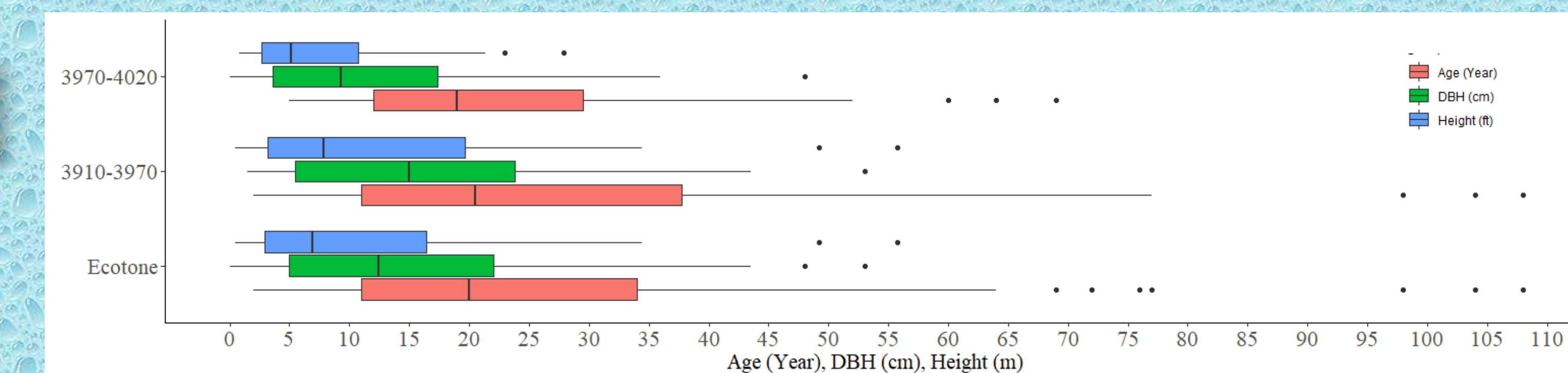


Figure 7: Age and size distribution in the ecotone. Upper and middle group of boxes represent the distribution in upper and lower half of the ecotone respectively, the lower boxes show the distribution over whole ecotone.

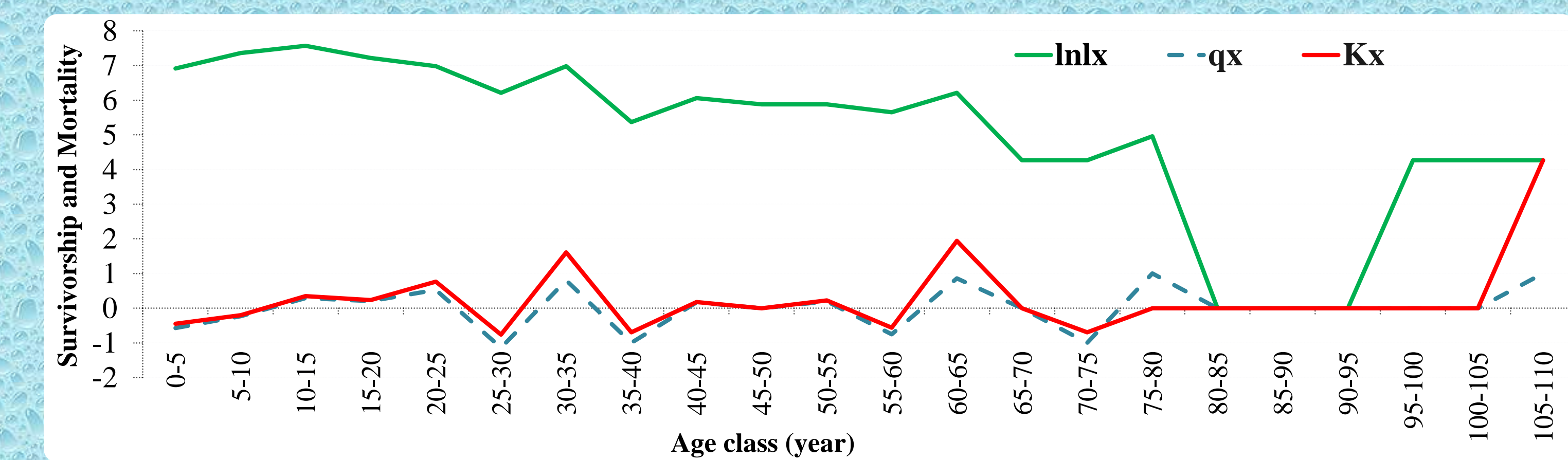


Figure 8: Recruitment and establishment in the ecotone explained by Survivorship (lnlx), Mortality rate (qx) and Killing power (Kx).

Conclusions

- Almost reverse J-shaped age structure indicates progressive regeneration and densification in the ecotone, but two youngest age classes may indicate the impediment in the process.
- Pronounced phase of pine regeneration and ecotone densification started by 1970s, with peak in 1990s.
- No distinct age, size and regeneration pattern with respect to elevation.
- Present location of forestline is ca. 3910 m asl. and that of treeline is ca. 4020 m asl. Present treeline position was gained by early 1990s.
- Type II survivorship curve as well as mortality rate and killing power denote the healthy regeneration and stand productivity.