The upper forest line in the Julian Alps

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SUMMARY

The forest line in the Julian Alps is the result of the complex interaction of several natural (climatic, orographic, edaphic, biotic) and antropogenic factors typical of the high mountains. They were responsible for the formation of different types of the forest line. We discern: the climatic (thermal and winds affected), the orographic and the antropogenic forest line. The course and the altitude of the natural and the actual forest line differ, because of the action of the physical geographical and social factors, even by several hundred metres. Two main species of trees (larch and spruce) grow along the forest line in the Julian Alps. The climatic (thermal) forest line is located at a higher altitude of 1900 m in the highest and the most massive central and northwestern part of the Julian Alps. The forest line is lower, because of the climatic conditions in the southwestern part of the Julian Alps, where it is at an altitude between 1550-1600 m above sea-level. In the higher and more massive interior of the alpine area the forest line climbs to altitudes of about 1700 m and even about 1800 m at the highest points.

The altitude, the physiognomy and the structure of the forest line in the Julian Alps are determinated by several factors related both to physical geographical as well as to social geographical conditions. The decisive role is played by the air temperatures and of particular importance are air temperatures during the vegetation period. Some authors assert that the forest line is located at altitudes where the July isotherm line does not excede 10°C (Marek 1905, Plesnik 1971). The comparison of the interpolated values for the mean July temperature of 10°C in separate parts of the Julian Alps reveals that it follows in the border areas of the mountain system, the altitudes of just above 1700 m above sea-level and slightly above 1800 m in the central part of the mountain system. This is, approximately, the altitudinal location of the forest line.

The growth of trees is affected also by other climatic factors, notably by precipitation. Precipitations are most abundant in the southwestern part of the Julian Alps. The higher parts of the Kanin group receive over 3000 mm of precipitations in a year, but the situation is similar also in the central parts of the mountain system. Snow is quite important for tree growth because of its positive influences (protection of the soil from frost and winds), but also negative influences (mechanical damage to trees, retention of growth). The

thickness and the length of duration of the snow cover is of particular importance. The forest ground is covered by snow up to six months in some parts and to the relative height of even as much as 3000 mm.

The trees, notably the tree-tops are strongly influences by the winds. At higher and exposed locations the lasting and strong winds cause the wind-shaped tree-tops. The tree-tops are asymetrical, with branches developed only on one side (i.e. flag shaped (Fig. 1). This is typical of particular trees above the forest line that are more exposed to the winds.

The Julian Alps are characterised by very vigorous relief forms. The glaciers during the Pleistocene period have considerably remodeled the former land-forms. Deep glacial valleys with steep slopes and glacial steps have emerged. The soil from the steep, mostly limestone slopes has been removed. Also, the slopes are dissected by ravines. All this impedes greatly the tree growth. As a consequence, the forest line is very unequal, undulating up and down along the slopes. It is low on the slopes of the valleys below the very steep northern sides with abundant talus material.

The less inclined parts of the surface were affected by the formation of several karst phenomena (karren, limestone pavements, grooves etc.) and are, thus, very irregular and uneven. In such places, covered only irregularly with thin soil, no contiguous tree growth is possible. Therefore the forests are rather thin and clear woodlands are typical of the central parts of the Julian Alps.

FIG. 1 - The typical form of larch crown on the forest line in the central part of the Julian Alps.

The altitude of the surface and the compactness of the mountain system are among the factors related to land-forms that affect the forest line in particular by their influence on air temperatures. The high and compact mountainous block warms up earlier and more than the lower and more dissected parts of the mountain system. The central part of the Julian Alps has an average altitude of 2100 m. There the forest-line is at higher altitudes than in its border areas.

Mostly thin soils (classified as rendzinas) have developed on the hard or decomposed carbonate parent rock material in the Julian Alps. They differ in regard to the thickness and the proportion of the organic matter. The soils consist of a dark and humified A horizon that passes over into the parent material. Only in places (e.g. on the moraines) is found, under the humified horizon, a more clay-like red-brown B horizon. In many places near the forest line or below it, the soil does not cover the surface and barren rocks stick out. All this discourages the growth of trees and bushes.

At lower altitudes the Julian Alps are mostly overgrown by the alpine beech forest *(Anemone trifoliae - Fagetum).* The mainstay of the forest are beeches which - in some areas - have been cut down and replaced by spruce trees. In narrower valleys with moister air beech is intermixed with maple.

Beech does not thrive well at altitudes of 1200 to 1300 m. Trees there are low and, in locations exposed to the winds, get flag shaped tree-tops. Spruces and individual larches more and more supplement the beeches. On the bottom of karst basins and depressions, where cold air is stagnating, the spruce is entirely dominant. This is the domain of the spruce forest *(Piceetum subalpinum).* On less cold slopes another spruce association *(Adenostylo glabrae - Piceetum)* tends to spread out (Wraber M. 1970; Puncer, Zupančič 1970). Such a forest covers considerable parts of the Julian Alps.

At higher altitudes the spruce *(Picea abies* L. Karsten) is more and more intermingled with the larch (*Larix decidua* Mill). These two species form the forest that reaches the forest line. In some places the larch is dominant (Fig. 2). Mixed spruce-larch forests form the forest line e.g. in the Krn mountain group. Light, almost pure larch forests reach the upper line in the central part of the Julian Alps, e.g. above the valley of the Triglav lakes. At higher altitudes in the subalpine belt above the forest line the dominant association is the *Rhodothamno-Rhododendretum hirsuti laricetosum* (Hegi, Merxmüller, Reisigl 1980). In it, *Pinus mugo* Turra is preponderant in lower locations but individual larch and spruce trees stick out. They find growing conditions further above more and more unfavourable, get smaller, twisted, tend to desiccate and gradually disappear. The association *Rhodothamno-Rhododendretum hirsuti mughetosum* is there entirely dominant.

The herb and grass vegetation extends on the higher ground above the belt of bush vegetation. Two associations: *Seslerio - Caricetum sempervirentis* and - on even higher ground - *Gentiano terglouensis - Caricetum firmae* are dominant (Wraber T. 1974).

The course of the forest line is not influenced only by natural factors but

FIG. 2 - The larch forest line above the valley of the Triglav lakes.

also by Man. The lighter woodland along the forest line was mostly cleared away in order to make land available for alpine pastures. The natural forest line was thus pushed downwards. A new, secondary, man-made forest line has come into existence. Later on, when the number of domestic animals on alpine pastures decreased, the role of the grazing along the forest line began also to decrease and the trees slowly tended to regain the lost ground at higher altitudes. Such a man-made forest line, however, has remained on more gentle slopes where the grazing has continued.

The biometric measurements of the trees along the forest line in the Julian Alps have revealed that the natural, climatic (thermal) line is located at higher altitudes than the present (actual) line. On steep slopes and under the rock walls with talus material, the orographic forest line is the characteristic feature. Still, the present forest line in many sections is not a natural one but an anthropogenic one.

The climatic (thermal) forest line in the northwestern part of the Julian Alps is located at higher altitudes of approximately 1900 m. The climatic (thermal) line above the north facing valleys (Vrata, Krma, Kot) with very steep slopes and rock walls is an abstract one because the forest - due to land-forms - cannot reach that line.

The climatic (thermal) forest line in the central part of the Julian Alps is located at a considerable altitude. There the larch trees fifteen metres high

grow at the altitude of 1728 m and even at the altitude of 1790 m the larch trees are still ten metres high.

The terminal branchlets of the larch have a length of 11 cm which shows that thin forests could still exist at such altitudes, in such conditions (Fig. 3). It is, therefore concluded that the by climatic forest line is located at altitudes of 1900 m. Such altitudes by climatic forest line can be reached also on the southern and eastern slopes of the Triglav mountain.

The climatic forest line in the western part of the Julian Alps is at an altitude of some 1800 m. The actual forest line, however, does not reach that altitude on the slopes to the south of the main ridge. In the upper Soča area it is at an altitude of some 1700 m and even lower on the mountain slopes in the southern and southwestern parts of the Julian Alps. Crippled trees and their physiognomy indicate that the forests could reach only the altitude of 1600 m. The climatic (thermal) forest line is even slightly lower on the most southern mountain ridge of Matajur, where the remaining trees show that the original forest extended upwards only at an altitude between 1550 and 1600 m above sea-level.

The forest line on the slopes of these peripheral parts of the Julian Alps is characterised, apart from its low altitude, by other features by which it differs from the forest line in the central and northern parts of the mountain system. Both the tree species and the physiognomy are different. Because of the climate (temperature, precipitation, cloudiness) and landforms even the original (natural) forest did not extend upwards as high. The belt of mixed spruce and beech forest is not well developed in that peripheral area. Not only natural factors are responsible for the existing situation, but also the

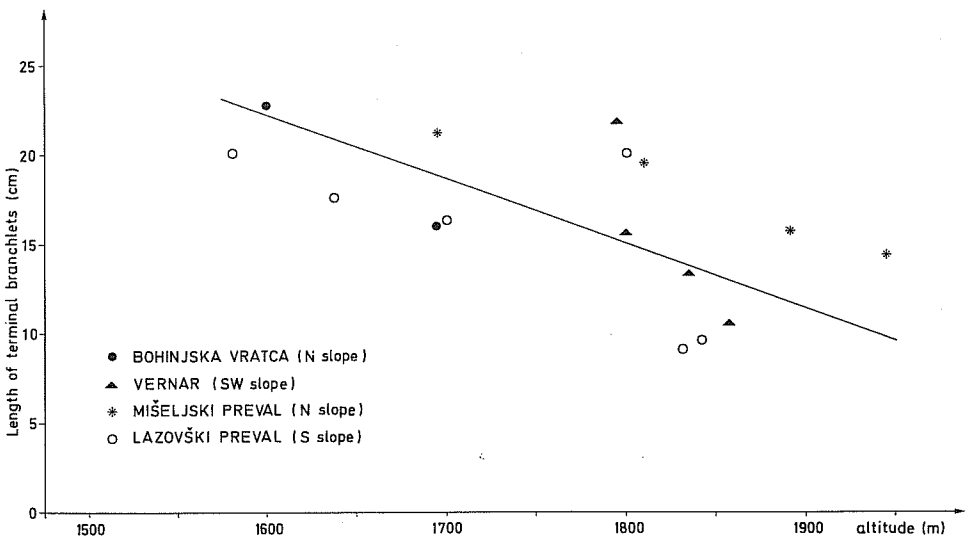

FIG. 3 - The diagram of the mean lengths of the terminal branchlets of larch in central Julian Alps.

marked action of Man. Forests were cleared not only for pastures but also for the sale of timber to nearby lowland areas.

CONCLUSION

The forest line in the Julian Alps is a result of the complex influence of several factors. The most important are the air temperatures, the land-forms and the soils as well as the action of Man that has changed both the altitude and the physiognomy of the forest line. Thus we can discern, with regard to all these factors, the natural (primary) and the man-made (secondary) forest line. They differ in altitude by 100 m and even more in place. With regard to the limiting factors for tree growth we discern: the climatic (thermal and winds affected), the orographic and the anthropogenic forest lines.

Negative impacts of the change of the vegetation along the forest line should always be taken into consideration. The clearance of forests increases the danger of avalanches and the erosion processes are intensified which can cause great economic distress to the valleys. This is to be taken into consideration even at present time when ski-runs are developed for winter sports often just along the forest line.

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