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PHOTOINTERPRETATION SURVEY OF CHANGES IN THE RANGE OF THE TATRA SUBALPINE FORESTS

The unique geographical environment of the Tatra Mountains compels us to take special care about its unparalleled natural qualities. Climatic conditions, among other things, tend to destroy plant cover, which not only depletes the landscape but also increases vulnerability of rock to the destructive action of erosion. To learn in every detail the dynamics of changes, and to classify their causes, is essential if we want to put an end to harmful effects of the nature itself.

In an attempt to find out the extent and the type of changes in the Tatra Mountains plant cover, recourse was made to a photogrammetrical 1:20000 map of the Polish Tatra published in 1934 and to the 1:20000 panchromatic aerial photography of 1977.

The aim of the study was to delineate the upper forest limit and to follow up changes that had taken place in the subalpine forest acreage. Air photographs in hand featured high resolution and good contrast so that there was no problem in discriminating and identifying the existing plant formations. In stereoscopic observations one could discriminate: dense forest, less dense forest, groups of trees and individual trees, clearings and meadows, dwarf mountain pines, water runs, roads and paths. Phototonal diversification, the structure and the texture of images as well as contours and the shape had been adopted as a criterion for the discrimination of various plant classes. The dwarf mountain pine floor was the last floor to discriminate. The overlying Alpine meadows floor was distinguishable in some places only; in most cases, it was hard to discriminate it from the rock overgrown with moss and lichen. To carry out a comparative analysis it was necessary to cart down vegetation floors evident from air photographs. Large altitude differences resulting in the shift of radial points, by several tenths of millimitres in many a case, imposed the need to use portable Radial Line Plotter (Ciołkosz et al 1978) and to base carting on the radial triangulation principles. By empirical standards, the accuracy of carting was 1 mm in model scale and came to mean as such the rate of generalization for the contours.

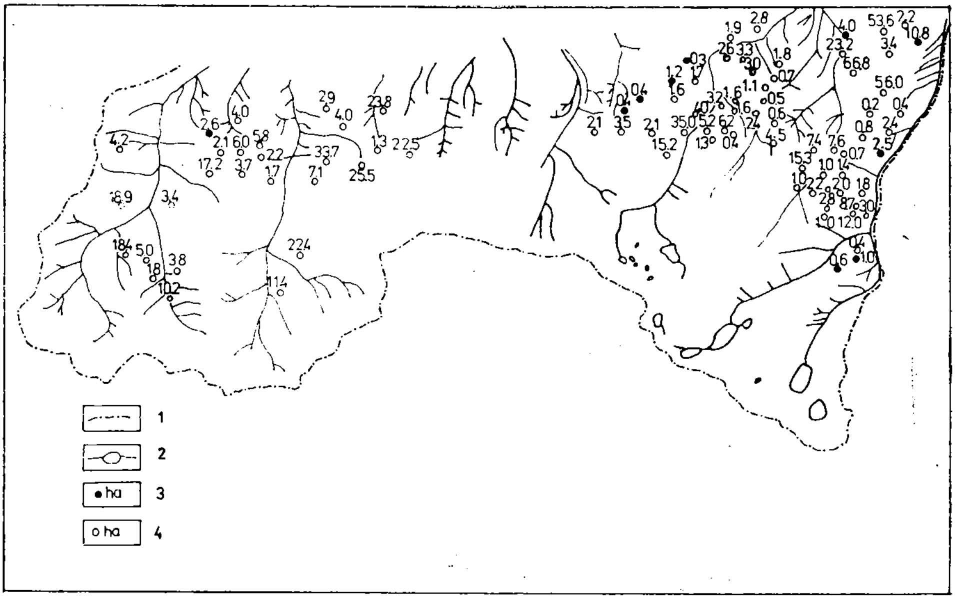

Fig. 1. The Polish Tatra Mountains stand depletion in the upper and lower subalpine region forests.

As a result of comparison made between the 1934 photogrammetrical map and a map developed against the air photography data for the stand of trees there was produced a map showing the depletion of stands in the Tatra Mountains subalpine forests (see Fig. 1). Further on, an attempt was made to analyse in detail every lot of area marked on the map and so it became possible to say which of the natural factors were likely to have the greatest impact as regards forest depletion, and to delineate areas of exposure to threat in the Tatra Mountains National Park stands.

In the course of 34 years, depletion in the stand of subalpine forests has been as high as 652.6 hectares. Among the damaging elements most notable are: foehn winds, which in the opinion of some authors (Myczkowski 1974; Sokołowski 1934) are said to be responsible for the greatest losses, avalanches, frost and snow formations on trees, bark beetle and animals. The dwarf mountain pine protects the forest against avalanches in a natural manner. Snow and frost destroy mostly deciduous stands in the 400—800 m above-sea-level zone. The Tatra forests situated higher than that are less exposed to their damaging action. Damages due to animals and bark beetle apply, as a rule, to separate trees and are overcome by foresters in a relatively short time.

Table 1

Forestation losses as a function of altitude above sea level in the Tatra National Park between 1934 and 1977

Altitude mtrs above sea level	ha	%
900–1000	47.0	7.2
1000–1100	118.6	18.2
1100–1200	175.5	26.9
1200–1300	146.8	22.5
1300–1400	100.5	15.4
1400–1500	63.4	9.7
over 1500	0.3	0.05

The hurricane-like foehn winds, seen as the most imminent element, break down hectares of forest within a day or so. The hurricane wind of 1968, put down spruce stands over an area of 1600 hectares. Damages due to this wind are evident from the aerial photography. The area of each gap thus produced has been calculated, and its position has been analysed in every detail. The analysis helped to identify elements that made the stands of trees so vulnerable to the destroying action of wind.

The most significant elements are felt to include: exposure and the inclination of slope, the altitude above sea level, geological bedding, species-oriented composition and the age of stands.

THE IMPACT OF EXPOSURE AND INCLINATION OF SLOPES

In Figure 2 the percentage distribution of damages in various sectors

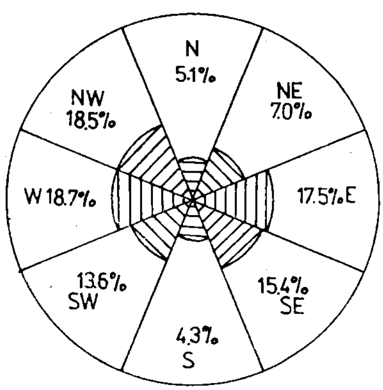

Fig. 2. Percentage distribution of damage in various exposure sectors for the whole Polish Tatra Mountains territory.

of the exposure for the whole Tatra Mountains' area is shown. According to the situation on the slope, they can be divided into:

(a) Damages due to the downcoming wind on the northern and similar slopes (30.6%);

(b) Damages due to the cross-wind blowing in parallel with the W and E slopes (36.2%); more damages seen on western slopes derive from a higher pressure on them in the second phase of the foehn wind. A relatively high percentage of damage in the NW sector (18.5%) results from two types of blast acting at the same time, the down-coming in the first phase and a cross-acting in the second phase.

(c) A relatively small percentage of damage disclosed on the southern slopes seems to corroborate Sokołowski's theory that, "the mountain forest proves more resistant to the blast of an upgoing wind" (Sokołowski 1928, 1934).

Most damages are largely dependent on the inclination of land, too. Three following cases are likely to occur in such circumstances (Fig. 3):

(a) Mild slopes with the blast of wind hitting them frontally cause losses in the highest wodland parts and make upper boundary of the forest come down. (Fig. 3a)

(b) Steep slopes up to 1700 mtrs above sea level with the blast of wind attacking the forest not frontally, but going much lower and breaking through the dense plant cover leaving empty gaps behind (Fig. 3b).

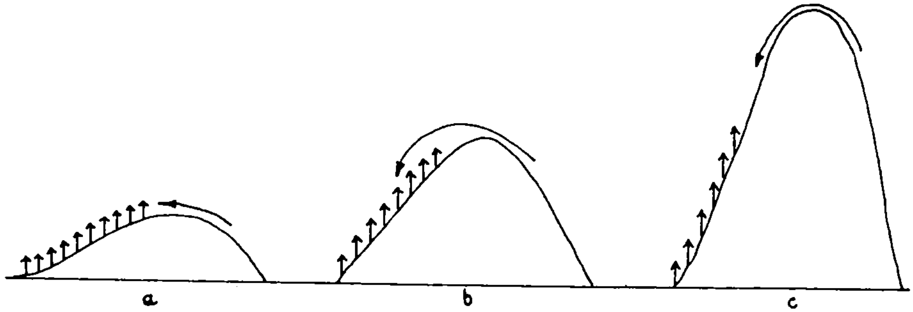

Fig. 3. The impact of slope inclination upon the upper woodland boundary course. a. Mild slope, b. Steep low slope, c. Steep high slope.

(c) Steep slopes over 2000 mtrs above sea level with the blast of wind leaping over and falling upon the leeward side still below the upper forest boundary. The situation is similar as in the first case. The frontally attacked forest lowers its boundary (Fig. 3c).

From the analysis of the angle of inclination it results that the largest gaps are those produced on straight 30-degree slopes.

THE IMPACT OF THE ALTITUDE

The impact of the altitude in combination with slope exposure has been shown in the diagram (Fig. 4). The difference seen in the concentration of damage on slopes looking north-west and north-east corro-

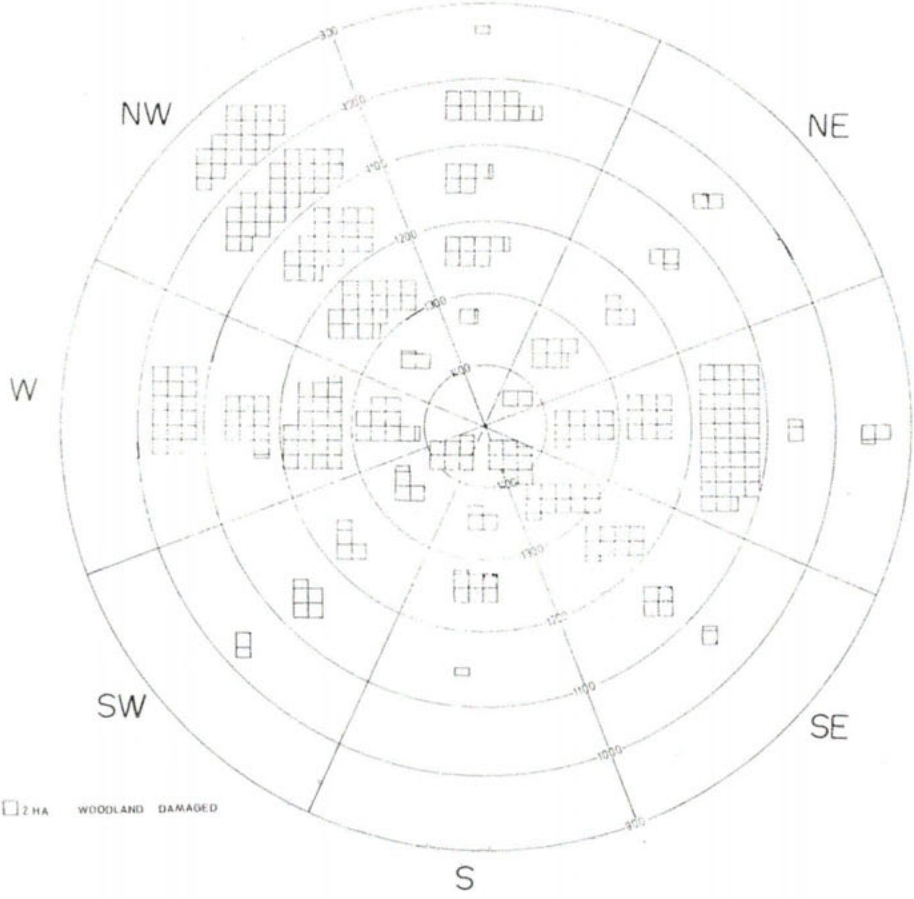

Fig. 4. Forest devastation in hectares of woodland damaged according to exposure and altitude above sea level.

borates the theory cited about the noxiousness of cross winds blowing at right angles to the inclined slope surfaces. From table 1 it is evident that the area of the greatest losses is extending at 1000 to 1300 mtrs above sea level (67.6%).

The zone of the most extensive damage as found from the air photography agrees with that proposed by Sokołowski (1934), according to 1926—1930 observations, and runs 200 mtrs higher than the 1968 belt of damage as marked out by Bzowski and Dziewolski (1973).

THE IMPACT OF GEOLOGICAL BEDDING

The most extensive forest depletion followed in the Quaternary formations. In the gravel-and-sand fluvio-glacial soils it ran as high as 35.4%, whereas in the debris-clayey moraine terrain 27.1%, i.e. 62.5% altogether. These are mostly initial soils offering rather poor conditions for the cultivation of spruce.

The remaining losses have been revealed in the limestone bed areas (34.9%), overlying the Triassic and Jurassic formations. Most of these areas (26.7%) form part of the West Tatra Mountains.

THE IMPACT OF THE SPECIES-ORIENTED COMPOSITION AND AGE OF STANDS

The marked areas of forest losses have been verified against the only available Map of the Tatra National Park Forest and Brushwood Agglomerations prepared by the Stefan Myczkowski's Group (1974). The bulk of all destruction, 288.8 hectares, is found to have taken place in the upper subalpine spruce forest, 75.4 hectares in the lower subalpine spruce forest moraines. This corroborates the theory that the multi-species stands and the younger stands are more resistant to the blast of winds for the following reasons:

(1) More favourable root system in spruce and beech;

(2) Good support crowns of fir and beech can lend to the cranky spruce;

(3) No leaves in beech during the foehn wind season (smaller resistance);

(4) More favourable ratio of the root system weight to the weight of trunks and crowns in the younger stands.

The above-mentioned factors, which have a decisive impact on the resistance of woods to the damaging power of the nature itself, are closely linked with one another. When taking into account all factors analysed it should be possible to identify the most exposed areas.

The latter include: the north-eastern area between the Białka River valley and the Waksmund stream, the northern part of the Sucha Woda valley, the Small Meadow valley, and the Upłaz Miętusi region.

The arriving at these data was possible only thanks to air photography. This is the only study covering the stand of subalpine forests for the whole Tatra Mountains on the Polish side. An earlier study by

Sokołowski (1928, 1934) as well as by Bzowski and Dziewolski (1973) was limited to the Tatra National Park fragments. Air photography has proved to be an excellent source to identify position and the extent of woodland losses in a relatively short time, and to provide a first-class material for further investigations by forest service men and biologists.

REFERENCES

Bzowski M., Dziewolski J., 1973. „Zniszczenia w lasach Tatrzańskiego Parku Narodowego spowodowane przez wiatr halny wiosną 1968 r." [Devastations in the Tatra National Park Forests Due to Foehn Wind in Spring 1968], *Ochrona Przyrody*, vol. 38

Ciołkosz A., Miszalski J., Olędzki J.R., 1978. *Interpretacja zdjęć lotniczych* [Air Photography Discrimination], PWN, Warszawa.

Myczkowski S., 1974. *Rodzime drzewa Tatr* [The Tatra Mountains' Trees], Studia Ośrodka Dokumentacji Fizjograficznej, Kraków

Sokołowski M., 1928. *O górnej granicy lasu w Tatrach* [On the Upper Woodland Boundary in the Tatra Mountains], Kraków.

Sokołowski M. 1934. „Szkody od powału w lasach tatrzańskich i sposoby zapobiegania im w zakresie hodowli lasu" [Losses Due to Windfalls in the Tatra Mountain Forests and How to Prevent them in the Silviculture]. *Prace Rolniczo-Leśne*, No. 10, Kraków.