

Vegetation Mosaic around the First Center of Tourism Development in the Uludağ Mountain, Bursa-TURKEY*

Gürcan GÜLERYÜZ, Hülya ARSLAN

Uludağ University, Arts and Science Faculty, Biology Department, 16059 Bursa-TURKEY

Mustafa GÖKÇEOĞLU

Akdeniz University, Arts and Science Faculty, Biology Department, 07058 Antalya-TURKEY

Helmut REHDER

Uludağ University, Arts and Science Faculty, Biology Department, 16059 Bursa-TURKEY

Received: 20.02.1998

Accepted: 15.05.1998

Abstract: In this study, the vegetation mosaic is determined by aerial photography and Geographical Information Systems (GIS) techniques around the first center of tourism development in the Uludağ Mountain. The cover of plant communities and vegetation types is calculated in both absolute values (ha) and as percentage (%) of the total research area. Dwarf shrub communities (*Vaccinium myrtillus* *Juniperus communis*, *Juniperus communis* and *Astragalus angustifolius* comm.) are dominant with a cover of 53%. There are some environmental problems caused by misuse of the area. The ruderal formation is dominant on the disturbed lands. It is widespread around the hotels, at roadsides and, especially, the recently made ski track.

Key Words: Vegetation types, GIS techniques, Mapping.

Uludağ Birinci Turizm Gelişim Merkezinin Vejetasyon Mozaïği

Özet: Bu çalışmada, hava fotoğrafları ve Coğrafi Bilgi Sistemleri (CBS) teknikleri kullanılarak Uludağ Birinci Turizm Gelişim Merkezinin vejetasyon mozaïği belirlendi. Bitki toplulukları ve vejetasyon tiplerinin toplam araştırma alanındaki örtülülüğü hem mutlak değer (ha) hem de yüzde (%) olarak hesaplandı. Birinci Turizm Gelişim Merkezi Çevresinde, *Vaccinium myrtillus* *Juniperus communis*, *Juniperus communis* ve *Astragalus angustifolius* bitki topluluklarının oluşturduğu bodur çalı vejetasyonu %53'lük örtü ile egemendir. Ruderal formasyon bozulmuş alanlarda egemendir ve oteller çevresinde, yol kenarlarında ve özellikle yeni yapılmış kayak pistlerinde geniş olarak yayılış göstermektedir.

Anahtar Sözcükler: Vejetasyon Tipleri, CBS, Haritalama

Introduction

By the end of 1997, 31 National Parks had been established in Turkey. Uludağ National Park one of the first, was founded in 1961 with an area of 11338 ha. Due to its altitude (2543 m) and various geological conditions, Uludağ Mountain is endowed with a rich flora containing numerous endemic species and forming several well-distinguished vegetation types. It is, however, also used as an important winter sport center with hotels and other facilities concentrated at the western slope between 1700 and 2150 m. Environmental problems due to

winter sport activities in this area are evident. These problems in the alpine area of the mountain have been discussed previously by Güleriyüz (1).

The aim of this study to use maps to show the plant communities of the part of the park that includes the hotels and disturbed areas as well as the adjacent original vegetation which had long been influenced only by extensive grazing. For this purpose, large-scale aerial photographs and Geographical Information Systems (GIS) techniques were used.

(*) This study is a part of the research project supported by the Research Fund of Uludağ University and Government Planning Organization (DPT, Project No: 91/24) of Turkish Republic

The vegetation types and plant communities above the timberline of Uludağ Mountain: Rehder et al. (2) investigated the vegetation of the upper region of Uludağ Mountain, which also includes the surroundings the Winter Sports Center. The vegetation of this region has been divided into the three main types: *Nardus stricta* meadows, *Juniperus communis* dwarf shrub and hard *Festuca* communities. According to this study, five vegetation types consisting of fourteen communities are distributed there: forest (*Abies bornmuelleriana* comm.), Dwarf shrub (*Vaccinium myrtillus*-*Juniperus communis* comm., *Juniperus communis* comm., and *Astragalus angustifolius* comm.), meadows and mat (*Nardus stricta*

comm., *Agrostis canina* comm., *Trifolium repens* comm., *Plantago atrata* comm. and *Plantago holosteum* comm.), hard cushion (*Festuca cyllenica* comm., *Festuca punctoria* comm. and *Acantholimon ulicinum* comm.) and ruderal (*Verbascum olympicum* comm. and *Achillea multifida* comm.). The main differential species of the plant communities and vegetation types are shown in Table 1. The vegetation mosaic around the Winter Sports Center in Uludağ Mountains is based on this vegetation study, in which details of climate, geology and characteristics of the vegetation types are presented. *Flora of Turkey and the East Aegean Islands* was referred to for the names of taxa cited in the text (3).

Forest vegetation

- Abies bornmuelleriana* community
 - Abies bornmuelleriana* Mattf. (Pinaceae)
 - Poa nemoralis* L. (Poaceae)
 - Galium rotundifolium* L. (Rubiaceae)
 - Fagus orientalis* Lipsky (Fagaceae)

Ruderal vegetation

- Verbascum olympicum* Bioss. (Scrophulariaceae)
 - Urtica dioica* L. (Urticaceae)
 - Rumex alpinus* L. (Polygonaceae)
- Achillea multifida* community
 - Achillea multifida* (DC.) Boiss. (Asteraceae)

Meadow and Mat vegetation

- Nardus stricta* community
 - Nardus stricta* L. (Poaceae)
 - Deschampsia caespitosa* (L.) P. Beauv. (Poaceae)
 - Ranunculus constantinopolitanus* (DC.) d'Urv. (Ranunculaceae)
 - Plantago gentianoides* Sm. (Plantaginaceae)
 - Crepis alpestris* (Jacq.) Tauusch. (Asteraceae)
 - Potentilla aurea* L. (Rosaceae)
 - Festuca rubra* L. ssp. *pseudorivularis* Margr.-Dannenb. (Poaceae)
 - Carex nigra* (L.) Reichard (Cyperaceae)
- Agrostis canina* community
 - Agrostis canina* L. (Poaceae)
- Trifolium repens* community
 - Trifolium repens* L. var. *orphanideum* (Boiss.) Boiss. (Fabaceae)
 - Poa supina* Schrader. (Poaceae)
 - Cerastium cerastioides* (L.) Britt. (Caryophyllaceae)
 - Tripleurospermum pichleri* (Boiss.) Bornm. (Asteraceae)
- Plantago atrata* community
 - Plantago atrata* Hoppe. (Plantaginaceae)
 - Plantago holosteum* Scop. (Plantaginaceae)
 - Alopecurus vaginatus* (Willd.) Boiss. (Poaceae)
 - Gnaphalium supinum* L. (Asteraceae)
- Plantago holosteum* community
 - Plantago holosteum* Scop. (Plantaginaceae)
 - Plantago atrata* Hoppe. (Plantaginaceae)
 - Alopecurus vaginatus* (Willd.) Boiss. (Poaceae)
 - Gnaphalium supinum* L. (Asteraceae)

Table 1.

Main differential species of the plant communities and vegetation types (based on Rehder et al. (2))

Dwarf shrub vegetation

Table 1 Continue

Vaccinium myrtillus *Juniperus communis* community

- Vaccinium myrtillus* L. (*Ericaceae*)
Bruckenthalia spiculifolia (Salisb.) Reichb. (*Ericaceae*)
Vaccinium uliginosum L. (*Ericaceae*)
Juniperus communis L. ssp. *nana* Syme (*Cupressaceae*)
Genista Lydia Boiss. (*Fabaceae*)
Galium album Miller ssp. *prusense* (C. Koch) Ehrend. Et Krendl. (*Rubiaceae*)
Crepis smyrnaea DC. ex Froenlich (*Asteraceae*)
Camplanula olympica Boiss. (*Campanulaceae*)
Senecio olympicus Boiss. (*Asteraceae*)
Juniperus communis community
Juniperus communis L. ssp. *nana* Syme. (*Cupressaceae*)
Genista Lydia Boiss. (*Fabaceae*)
Galium album Miller ssp. *prusense* (C. Koch) Ehrend. Et Krendl. (*Rubiaceae*)
Crepis smyrnaea DC. ex Froehlich (*Asteraceae*)
Campanula olympica Boiss. (*Campanulaceae*)
Senecio olympicus Boiss. (*Asteraceae*)

Astragalus angustifolius community

- Astragalus angustifolius* Lam. (*Fabaceae*)

Hard cushion vegetation

Festuca cyllenica community

- Festuca cyllenica* Boiss. (*Poaceae*)
Festuca punctoria Sm. (*Poaceae*)
Festuca paphlagonica (St.-Yves) Margr.-Dannenb. (*Poaceae*)

Festuca punctoria community

- Festuca punctoria* Sm. (*Poaceae*)
Festuca cyllenica Boiss. (*Poaceae*)
Festuca paphlagonica (St.-Yves) Margr.-Dannenb. (*Poaceae*)

Acantholimon ulicinum community

- Saxifraga sempervivum* C. Koch. (*Saxifragaceae*)
Thlaspi lilacinum Boiss. and Huet. (*Brassicaceae*)
Alopecurus lanatus Sm. (*Poaceae*)
Veronica caespitosa Boiss. (*Scrophulariaceae*)
Anthyllis vulneraria L. ssp. *pulchella* (Vis.) Bornn. (*Fabaceae*)
Acantholimon ulicinum (Willd. ex Schultes) Boiss. (*Plumbaginaceae*)
Olymposciadium caespitosum (Sm.) Wollf. (*Apiaceae*)
Silene falcata Sibth. et Sm. (*Caryophyllaceae*)
Scorzonera pygmaea Sibth. et Sm. (*Asteraceae*)
Androsace villosa L. (*Primulaceae*)
Astragalus hirsutus Vahl. (*Fabaceae*)
Carex kitaibeliana Degen ex Becherer
Gentiana verna L. ssp. *balcanica* Pritchard. (*Gentianaceae*)
Pedicularis comosa L. var. *sibthorpii* (Boiss.) Boiss. (*Scrophulariaceae*)
Euphrasia salisburgensis Funck. (*Scrophulariaceae*)
Onobrychis montana DC. ssp. *cadmea* (Boiss.) P.W. Ball. (*Fabaceae*)
Helianthemum canum (L.) Baumg. (*Cistaceae*)
Scutellaria orientalis L. ssp. *alpina* (Boiss.) O. Schwarz. (*Lamiaceae*)

Material and Methods

Material

In this study, we used aerial photographs of 1/10 000 scale belonging to Uludağ National Park to produce maps of 1/2500 scale.

Methods

Obtaining and Digitizing of the Aerial Photographs

The General Command of Mapping of the Turkish Republic took the aerial photographs of 1/10 000 scale from specially equipped planes in August, 1992. The longitudinal overlapping of the photographs is 60-90% and the latitudinal overlapping is 30%. These photographs were printed in triplicate in black and white in the General Command of Mapping laboratories, where they were digitized by orthophotography.

Determining of the Plant Communities

Determination of plant species and plant communities distributed the research area were based of the results of research done on the same are by Rehder et al. (2).

Marking of the Plant Communities on the Maps

The maps produced by the General Command of Mapping contained the coverages such as contours, rivers, hill points, rocks, water resources, buildings, under water lines, altitude values (at certain points), plant community boundaries, destroyed areas and roads. The maps produced from the aerial photographs contain about 25 square km of Uludağ National Park, and this total research area was divided into 20 sections of 1/2500 scale. The hotels and ski center are included in 4 sections of total area (about 6 square km).

Using the above sections of the map, the boundaries of the plant communities were checked by field study in July, 1993. Plant communities were marked on the maps with different symbols, and their boundaries were confirmed by this fieldwork.

Analysing and Editing the Results by Computer

The characteristics of the plant species (cover, frequency, density) in the grassland and changes in the cover can be traced using large-scale aerial photographs (4). In our study, areas of 200 square meters and larger were marked on the maps. This is fairly high resolution. Vegetation and other geographic data were analyzed according to GIS techniques (5), which improve the accuracy and efficiency of environmental assessments, especially the large-scale assessment. This technique allows us to record plant community boundaries, to prepare and edit a feature attribute table (vegetation type, cover, list of species, abundance degree etc.), and to calculate areas

(ha, m², km² etc.). In the GIS techniques, the term "coverage" represents the geographical layers of the real world. Each one of these layers (for example, hydrology, topography, streams, utilities, parcels etc.) is coverage. In our study, the boundaries of plant communities, contours, stream atc. concerned with every section 1/2500 scale were transferred to computer from digitizer (ALTEKTM). Each one of these coverages was separately filed in a computer environment (Hewlett-Packard Workstation Apollo Series 700TM). Feature attribute tables relating to each coverage were created with ARC/INFOTM software (ESRI, 1992) and these tables were related to geographical data. The end map compositions of 1/10.000 scale were prepared.

Results and Discussion

Uludağ Winter Sports Center (and the research area) is between altitudes of 1700-2150 m (Figure 1).

A vegetation map of the research area (about 6 km² or 600 ha) is shown in Figure 2 and 3. The sub-alpine plant communities are prevalent in this area. The covering of the plant communities is given in Table 2 in hectares and as a percentage of the total area. According to this table, dwarf shrub communities cover the largest part of the area. Dwarf shrub vegetation is composed of *Vaccinium myrtillus* *Juniperus communis*, *Juniperus communis* and *Astragalus angustifolius* communities. *Astragalus angustifolius* comm. is distributed in a narrow area, whereas the other two plant communities are distributed in larger areas, neighboring each other.

The meadow and mat formation is composed of *Nardus stricta* meadow and *Plantago holosteum* and *Trifolium repens* mat communities. The community covering the largest area within this formation is *Nardus stricta* comm.

Ruderal vegetation is widespread around the hotels and ski centers (Fig 2 and 3), indicating massive disturbances. Taking together the total destroyed and uncovered areas with the ruderal places we get the sum of 71.365 ha (12.057%) for disturbed areas as a whole.

Hard cushion communities, which are typical of alpine regions, are distributed from altitudes of 1750 to 2450 m. They are scarce in the mapped area, represented mainly by the *Festuca cyllenica* comm., whereas *Festuca punctoria* and *Acontholimon ulicinum* comm. are widespread only in the higher sites outside of our map.

With this study, the new formations and deformations caused by various activities since the 1940's around the first center of tourism development in the Uludağ

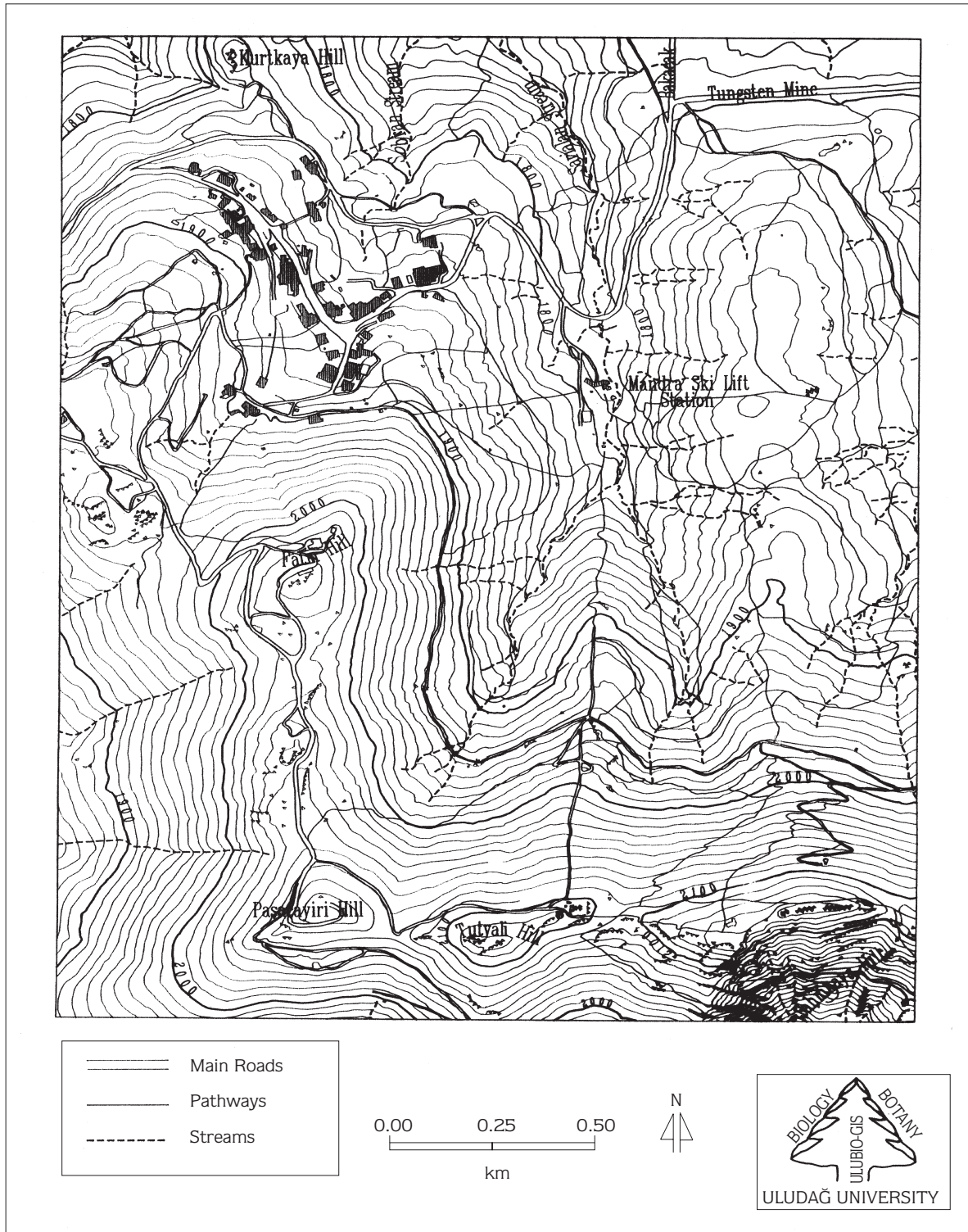


Figure 1. Geographical map of the investigation area

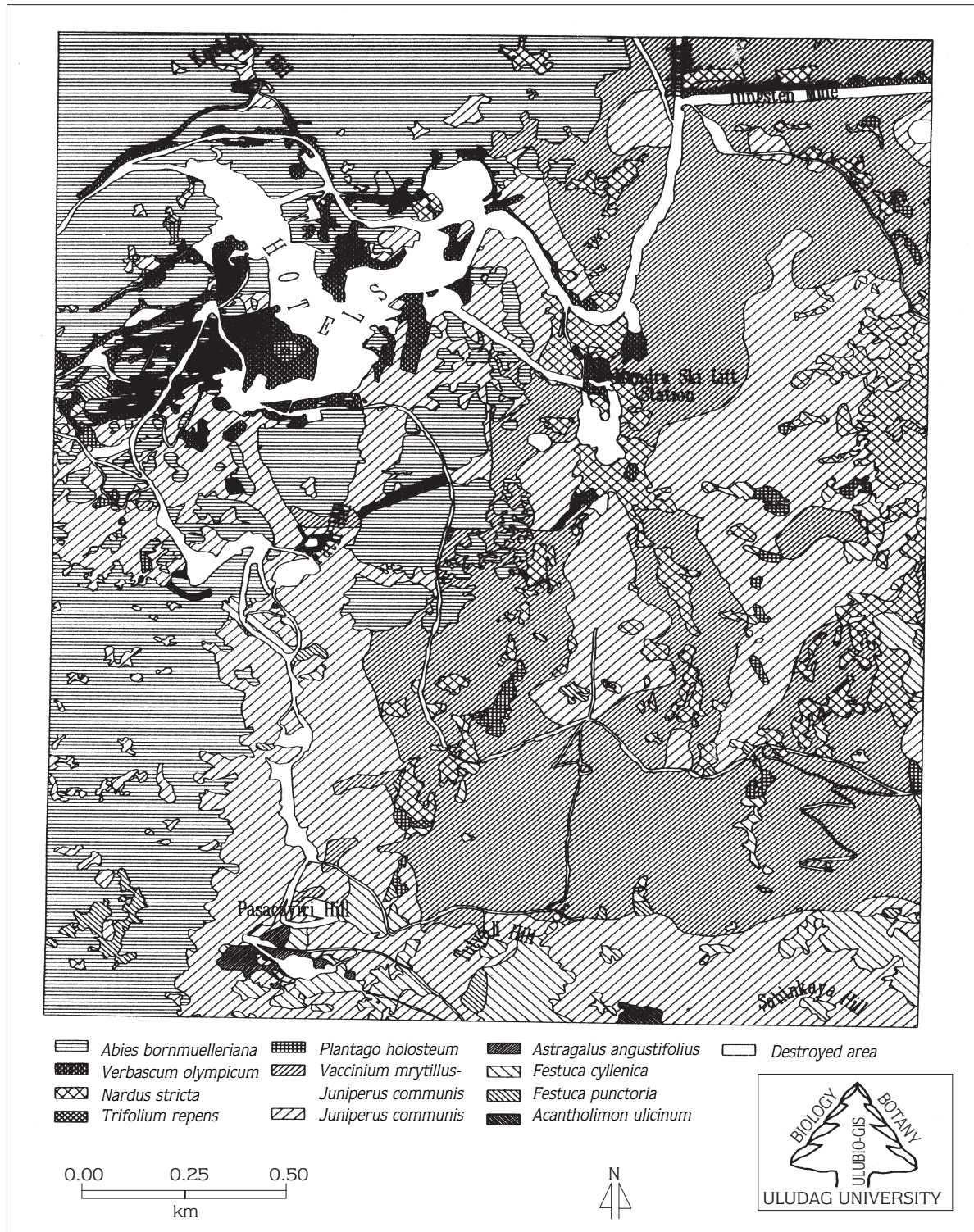


Figure 2. Map of plant communities around the First Center of Tourism Development

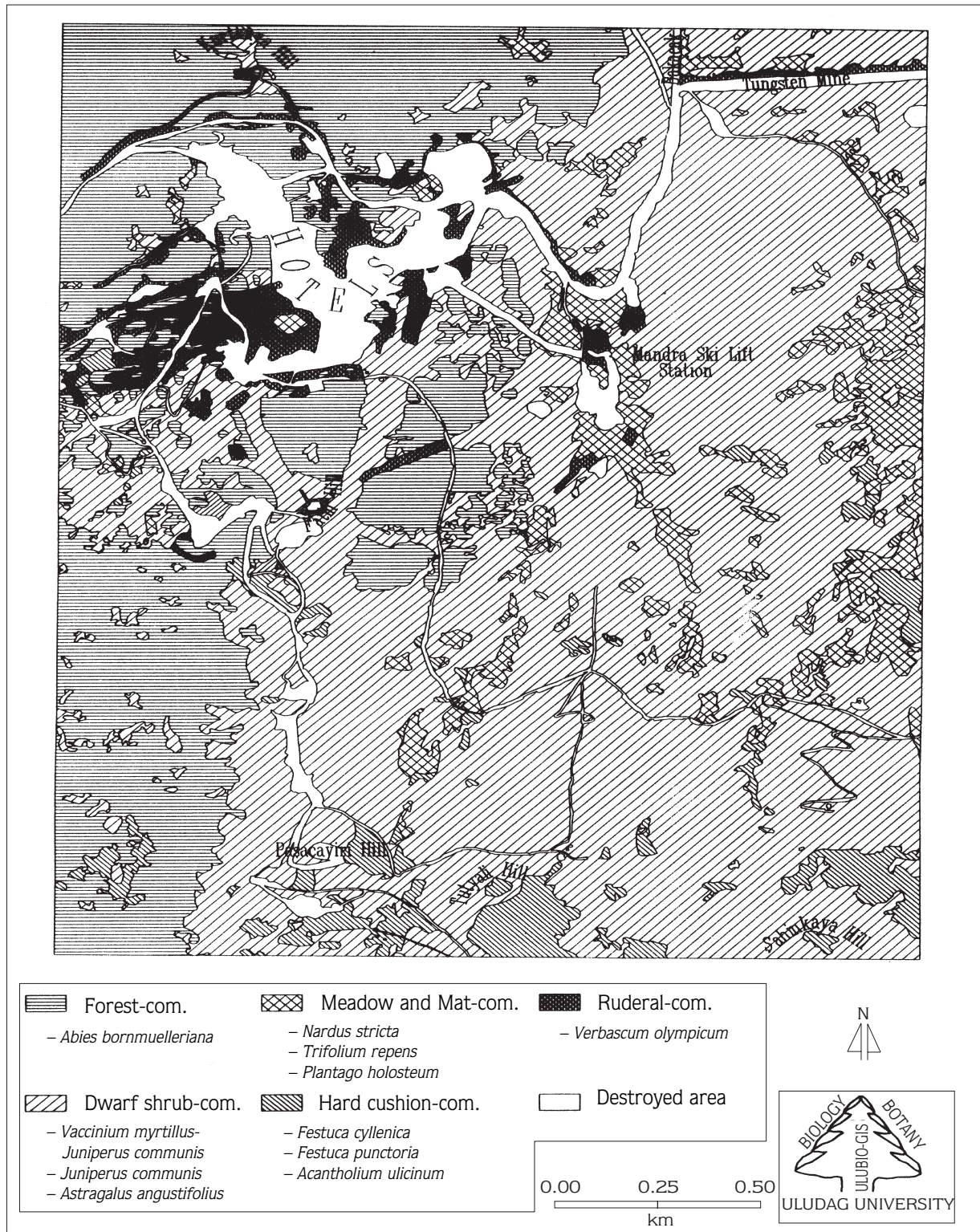


Figure 3. Map of vegetation types around the First Center of Tourism Development

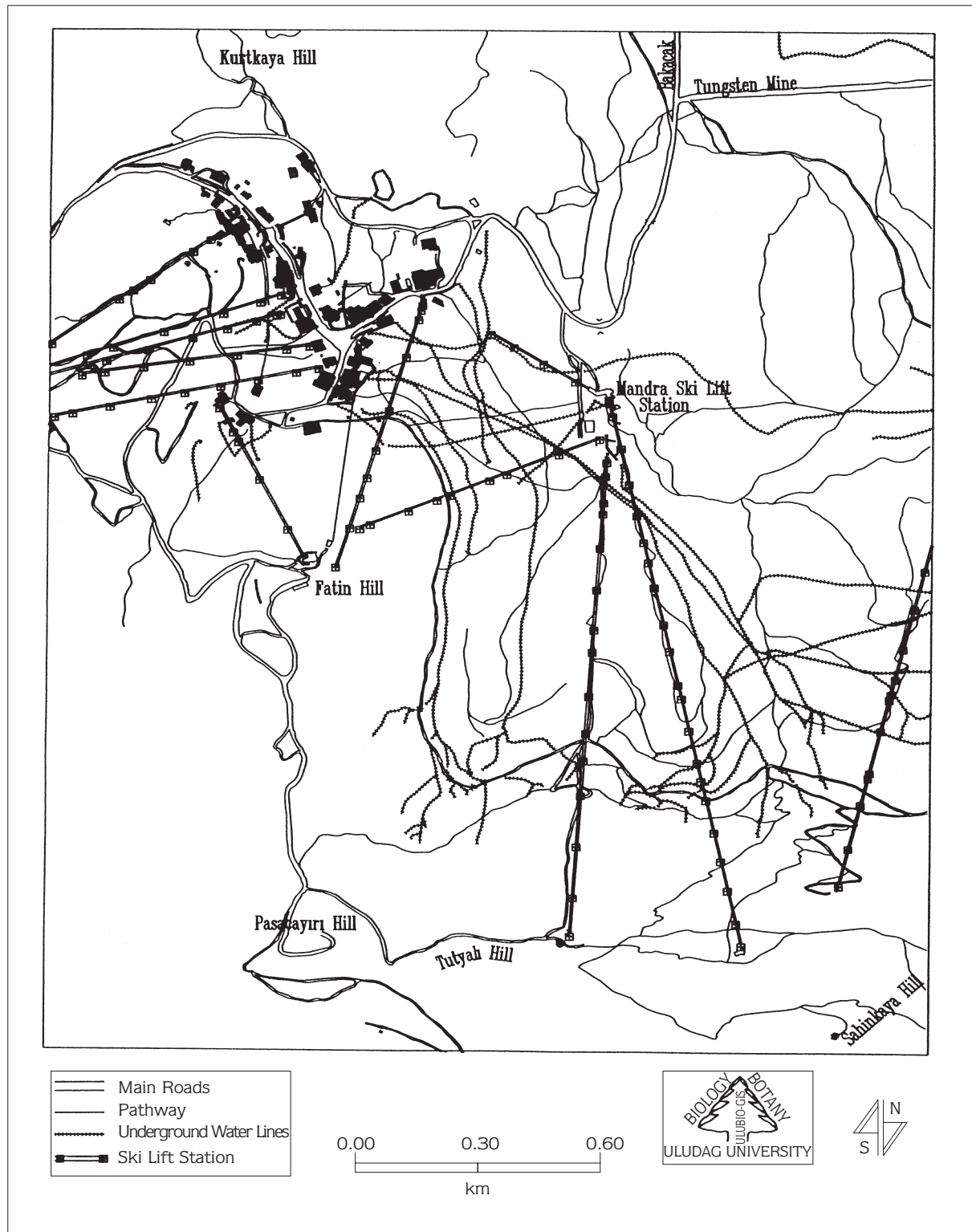


Figure 4. Map of the underground water lines and ski lift

VEGETATION TYPES and COMMUNITIES	AREA	
	ha	%
FOREST	141.386	23.885*
- <i>Abies bornmuelleriana</i> comm.	141.386	23.885*
DWARF SHRUB	315.926	53.372
- <i>Vaccinium myrtillus Juniperus communis</i> comm.	152.909	52.832
- <i>Juniperus communis</i> comm.	161.611	27.302
- <i>Astragalus angustifolius</i> comm.	1.406	0.238
MEADOW and MAT	37.763	6.380
- <i>Nardus stricta</i> comm.	33.485	5.657
- <i>Plantago holostium</i> comm.	4.129	0.698
- <i>Trifolium repens</i> comm.	0.149	0.025
RUDERAL	22.710	3.837
- <i>Verbascum olympicum</i> comm.	22.710	3.837
HARD CUSHION	25.494	4.307
- <i>Festuca cyllenica</i> comm.	19.680	3.325
- <i>Festuca punctoria</i> comm.	5.303	0.896
- <i>Acantholimon ulicinum</i> comm.	0.509	0.086
DESTROYED AREA	48.655	8.220
TOTAL	591.533	100.001

Table 2. Area (ha) and percent (%) of the vegetation types and plant communities within the total research area.

* Percentage of (%) community and/or vegetation type into total area.

Mountain are exhibited. For example, as of 1993 each hotel had its own water supply independent of the nearby springs. In this case, it means that each of them had to build its own water network, mainly composed of plastic pipes in the largest part of the area (Fig 4). Furthermore, as shown in Figures 2 and 3, excessive and disorganized road building is present in the area. These problems have been reported in a previous study (1).

It is possible to form an opinion about vegetation dynamics with the maps presented in Figures 2 and 3. For example, it can be seen that the ruderal formation has developed as a secondary formation after trees (*Abies bornmuelleriana* comm.) were cut to build a ski lift at the area between Fatin Hill and Mandra ski lift station. A similar case can be observed for the ski lift between the hotels and Fatin Hill. This area is located within the forest

formation and covered by dwarf shrub formation. Most probably, the shrub formation followed the ruderal vegetation growing first after trees were cut there.

In summary, we see a disorganized use of the area for sports indicated by the growing dominance of the *Verbascum olympicum* community. As a whole, this documentation may offer a base for comparisons of present plant cover with future changes. It appears that the changes will continue at an accelerating rate if the current negative human impact on this famous national park continues.

Acknowledgments

We thank Prof. Dr. Kani IŞIK for improvement of the English manuscript.

References

1. Güteryüz, G. (1994) Some Investigations on Alpine Region of Uludağ. 1st National Congress on Ecology and Environment, 5-7 October 1993. Atatürk Cultural Center, Izmir Turkey. Journal of Faculty of Science, Aegean University Supplement 16(1): 918-826.
2. Rehder, H., Gökçeoğlu, M., Gebauer, G., Güteryüz, G. (1994) Die Vegetation des Uludağ-Gebirges (Anatolien). Phytocoenologia, 24: 167-192.
3. Davis, P.H. (1965-1985) Flora of Turkey and the East Islands. Vol. 1-9, University Press Edinburgh.
4. Spelleberg, J.F. (1995). Evaluation and Assessment of Conservation Biology, Series 4. Series editor F.B. Goldsmith, Chapman and Hall, London.
5. Tueller, P.T., Lent, P.C., Stager, D.D., Jaeubsen, E.A., Platau, K.A. (1988). Rangeland Vegetation Changes Measured from Helicopter-Borne 35 mm Aerial Photography. Photogrammetric Engineering and Remote Sensing. Vol. 54, No. 5, pp. 609-641.
6. Understanding GIS. (1992) The ARC/INFO Method. Environmental Systems Research Institute. Inc. Redlands, USA.