ENVIRONMENTAL PROTECTION OF THE TATRA, PIENINY AND GORCE MOUNTAINS BY THE USE OF GEOTHERMAL ENERGY

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Tatra National Park – Zakopane. POLAND

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ABSTRACT

Poland is one of Europe's most polluted countries. This also applies to the Polish uplands that are of high natural and touristic value. Podhale basin, where geothermal waters have been discovered, is located between four national parks. A large scale ecological degradation is observed due to atmospheric pollution some 50–80% of which is due to emissions from the local sources. Geothermal water utilization for heating purposes in compact settlements (Zakopane, Nowy Targ, Biaty Dunajec, Bańska, Poronin, etc.) can beneficially influence the state of health of the population and the environment in national parks as well as in area's numerous nature reservations.

NATIONAL PARKS

The southern part of Poland is known as a territory of exceptional beauty, and it has high natural qualities. In this area, four national parks have been created due tn the high biodiversity of it's nature. The distances between national parks here are less than 50 km, and in between lies Podhale — a densely populated area whose economy is based on tourism. In the region, there are thousands of hotels, pensions, resting houses and other facilities focusing on tourism. Two relatively large towns are also here: Zakopane and Nowy Targ, with some industry in the latter. Every year, millions of people visit the area hnth during the summer and winter tourist seasons.

The idea of organizing national parks in this region appeared very early, e.g. in the second half of the nineteenth century in the Tatra Mountains. Ultimately, three national parks were officially organized in 1954, namely: Tatrzański, Babiogórski, and Pieniński. Gorczański National Park was created in 1980.

Tatra National Park

Largest in the region, and second largest in Poland, the Tatra National Park has an area 21,164 hectars, half of which is in strict nature reservations. The highest peak is Rysy at 2199 masl, and the variation altitude is over 1600 meters. Climatic zones are five (5) ranging frnm moderately cool (4–6°C) to cold (from –2 to –4°C). Vegetation shows high diversity with distinguishable zonation: low and high mountain forests up to 1550 mad, the dwarf pine zone (to 1800 marl), the alpine meadow zone (to 2300 masl) and higher the rocky peaks zone. The area is additionally differentiated according to the geological structures into the Western Tatras [limestone) and High Tatras (cristalline rocks). The flora contains over 1,000 species of vascular plants and more than 2,000 species of nonvascular plants with many endemics, and rare mountain species. A rich wildlife is rcprcscntod by typical mountain species, such as chamois (*Rupicapra rupicapra*) and groundhog (*Marmota marmota*) — species which in Poland live only here:. Tatra National Park has about 25U km of foothpaths, 8 mountain shelters, as well as many other facilities. Tatra mountains are an important center of popular and professional winter sports. The TNP research station coordinates up to 100 scientific programs annually, and the nature museum presents natural values of the park. In 1992 Tatra National Park became a MAB Biosphere Rcscrve (Krzan et al. 1993).

Pieniny National Park

The total area of the park is 2328 hectars, of which 25% are strictly nature reservation. 'The highest peak, Trzy Korony, (the three crowns) is 982 masl. The Park is covered by forests, meadows, and farmland. The climatic zones encompass a moderately warm zone (6–8°C), and a moderately cool zone (4–6°C). There are 1100 species of vascular planrs with many endemics and rare species. I'he whole area is located in a low mountain forcst aonc, with a beech-fir forest dominant. The very diversified fauna of the park contains 45 species of mammals, t70 species of birds, and numerous fauna of invertebrates. Pieniny National Park is also an interesting historical site. Tourist foothpaths totaling 28 km in length and the very attractive Dunajec Canyon passable by boat, as well as many other tourist facilities make the park very popular lor visitors. There is currently no nature museum, bur a small permament nature exhibition exists in Niedzica castle (Salmon 1993).

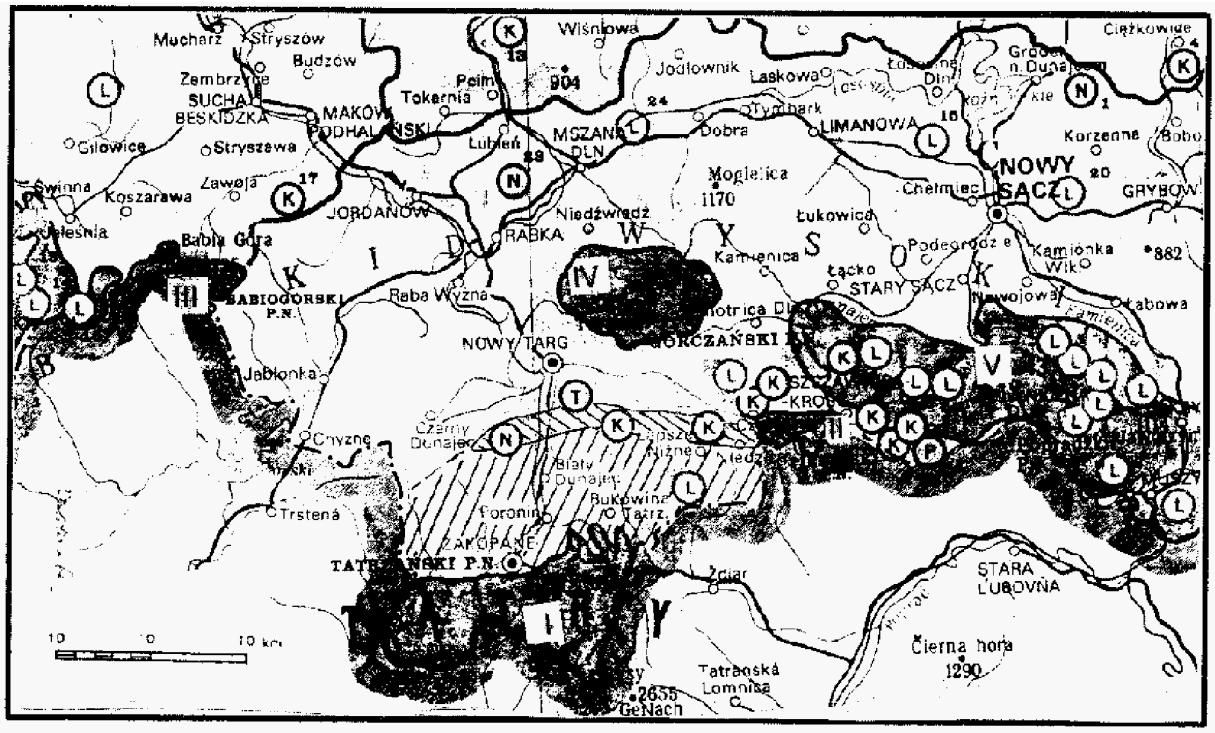
Gorce National Park

The total area of the park is 6743 hectars, of which 2850 ha are purely a nature reservation. The highest peak rcaches 1288 m above sea level. The majority of the area is covered by mountain forests. There arc 3 climatic zoncs in the park ranging from moderately warm (6–8°C) tu cool (2–4°C), and two well determined vegetation zones: low and high mountain forests. The flora of the park includes about 930 species of vascular plants, and over 700 species of nonvascular plants with many mountain and high mountain species. The fauna of the park has not been fully documented yet, but there art. over 100 species nf birds, and 36 spccics of mammals living there. There are 10 tourist footpaths, arid a shelter on Turbacz Mountain, as well as camping areas. A comparatively young Gorce National Park has no nature museum, a scientific station is now in organization (Żurek 1993).

Babia Góra National Park

The total area of the park is 1734 hectares, 'I'he highest peak, Diablak is 1725 masl and the o/a altitude change is 900 meters. Over 1060 hectares are under strict nature protection, and most of the area is mountain forests Climatic zonation is connected here with altitude from moderately warm with mean yearly temperature 6–8°C to the moderately cold at the highest peak level (mean annual temperature from 0°C to –2°C). In connection with climate, 4 main zones of vegetation exist: low and high mountain forests zones, the dwarf pine zone and the alpine meadows zone.

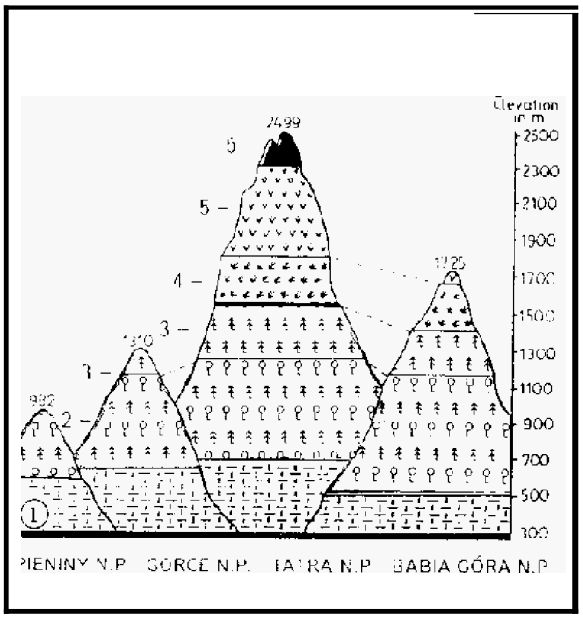
The flora of Babia Góra National Park has about 700 species of vascular plants, as well as over 1000 species of nonvascular plants and contains many rare and endangered species. The



Podhale geothermal basin; Pieniny Klippen Belt; National parks: I – Tatra, II – Pieniny, III – Babia Góra, IV – Gorce, V – Poprad Landscape Park, Nature reserves: (L) forest, (T) peatbog, (N) inanimate nature, (K) landscape, (P) bird

Fig. 1. Podhale region: Location of geothermal basin, national parks and nature reserves

Fig. 2. Location of Podhale region in Europe



1 – submontane zone, 2 – lower (mixed) forest zone, 3 – upper (coniferous) forest zone, 4 – dwarf pine (subalpine) zone, 5 – alpine grasslands zone, 6 – zone of summits

Fig. 3. Vertical distribution of natural vegetation in the Pieniny N.P., Gorce N.P., Tatra N.P., Babia Góra N.P. (Biosphere Reserves in Poland)

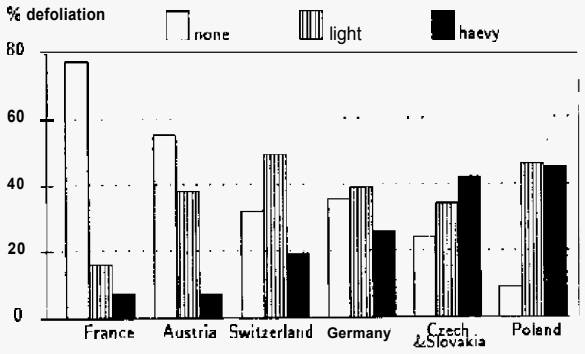


Fig. 4. Defoliation of forests, 1991

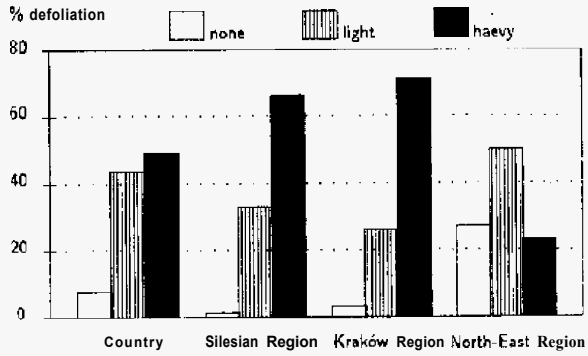
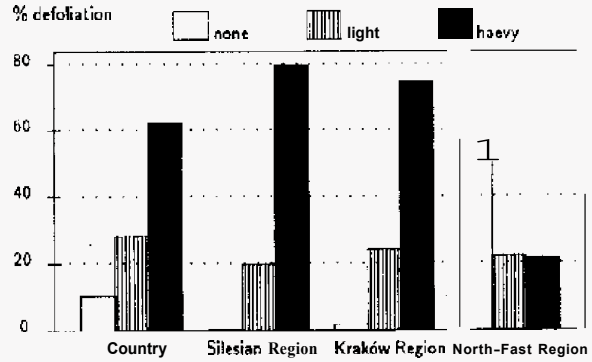


Fig. 5. Defoliation of forests, Poland 1992



Fag. 6. *Defoliation of forests: Norway Spruce 1992*

fauna **of the park** is also highly diversified with 166 species of vertebrates **and over** 24W **invertebrates.** In the park's area **thcrc** are 36 **kilometers** of tourist footpaths, **and a** few other tourist **facilities** such **as shelters, camping arcas,** muscum of nature and **others.** Babia Gora is **a** significant center for both scientific re**scarch and** training of **students.** Since 1976, **Babia** Góra **has** been **a** MAB biosphere reserve through UNESCO (Parusel 1993).

CURRENT POLLUTION OF THE **ATMOSPHERE**

Compared to other European countries, Poland **is seen** to be one of the most polluted **one.** [Fig. 4, 7, 8). Comparing pollution inflow to Poland **(Fig.** 5), it **can** be **seen** that the Podhale **region** is even **worse** than the most pollution degradated Silesian region. The percentage of heavily defoliated trees is 70%, and there arc only **few** percent of non defoliated **trees. This** situation is quite different than in **the** cleanest north eastern part of **Poland.**

In the Podhale region, Norway Spruce is a dominant **tree** specy, and its health condition can be **used as an index of** nature **degradation. Data** from **1992** (Fig. **b)** shows, that also in this **case,** forest degradation **in the** region is closer to that in the badly affected Silesian **region** than in :he cleanest North-East.

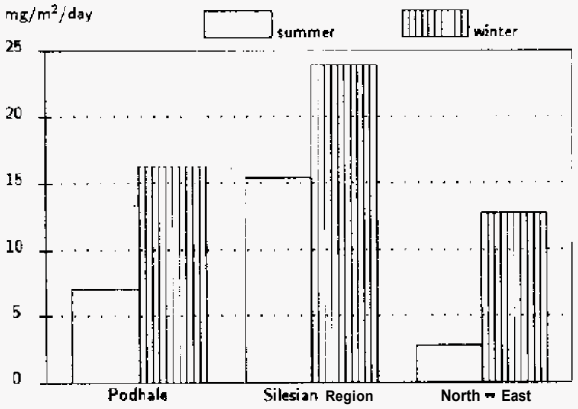


Fig. 7. Average ingress of SO, by regions (1986–1992)

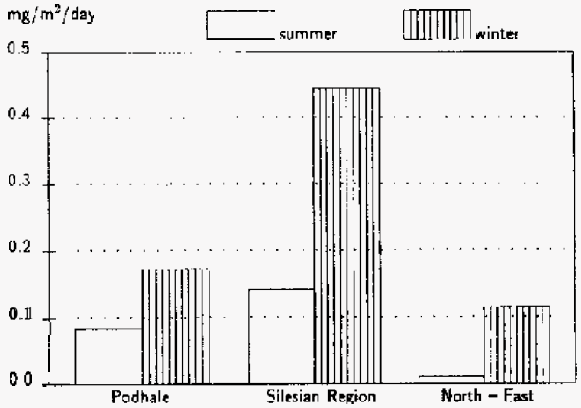


Fig. *8. Average ingress of NO_x by regions (1986–1992)*

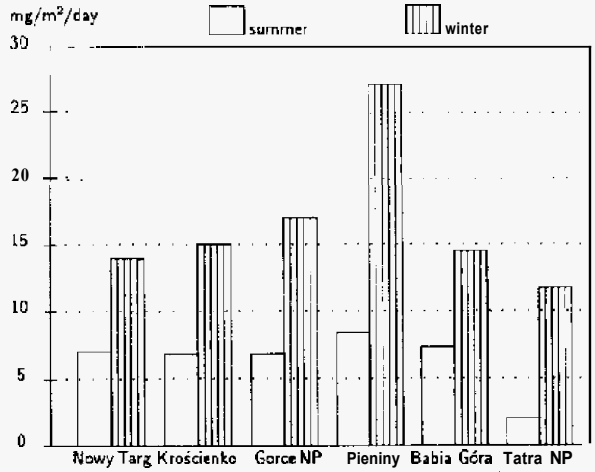


Fig. 9. Average ingress of SO_2 in Podhale (1986–1992)

Because of the program of permanent monitoring **of air pollu**tion begun in 1985 by **the** Forest Research Institute (Wawrzoniak **et al.** 1986–1992), we can recognise the **actual situation in** the field **of air** pollution. Air pollution **is** the primary cause of ecological threats. **As** can **be** seen from the graph of SO_2 (Fig. 7) and NO, **(Fig.8),** ingress into **the** Podhale region **is quite** close **to that** in **the** badly **polluted** Silesian region **as** opposed to **the situation** in the comparatively **clean** North-East of the **country.** Pollution **is higher** during **the** winter **seam**, which is closely related to the coal heating **system** dominant in the **densely** populated Podhale area. It has been **shown** that **50–80% of** the air pollution is **af local origin,** although long distance influences from rest of Poland and other European countries **arc** also **observed. Air** pollution is influencing the **Podhale region** significantly, and **was** determined **a** major threat to our natural heritage. The worst situation (using SO_2 as an example) is **in** the Pieniny **Sational Park** (Fig. **9),** . **as compared** to **Gorce National** Park **and** rest of the area,

The Tatra National Park appears to be the comparatively cleanest place in the entire Podhale region. The average SO, ingress there is 3 to 4 times lower than in Pieniny or Gorce. However, field observations show that defoliation is serious in the Tatras, and, in many places, it is quite close to complete. defoliation of spruce and fir. Because of biological monitoring of lost needles in about 40 permanent plots inside the park. we can investigate actual defoliation and try to determine degree of risk of total defoliation of Tatra forests. From printed reports. and unpublished data, we know that, in other national parks and the rest of Podhale region defoliation is even worse than in the Tatras.

There is only one way to effectively protect nature against air pollution viz. to significantly lower its level. As was stated using the Tatra Mountains as an example, 50 to 80% of pollution comes from local sources especially the coal heating system which predominates in the region. Presently used energy sources have to be substituted for other cleaner ones: electricity, natural gas, solar or wind power, as well as absolutely clean geothermal energy. The best solution is to utilize a number of the possible alternate energy sources. Geothermal water is an important option.

GEOTERMAL POTENTIAL

Because of the long-term impact of degradation factors, the state of the environment is very bad. It refers mainly to soils and waters causing progressive decrease of flora and fauna. Some species of animals and trees deteriorate. Every third tree progressively defoliates in the Tatra National Park. If such degree of degradation continues with the same intensity it then can within next 30–60 years result in the total defoliation of forests in this region. This may furthermore result in the flooding and land erosion, presently stopped by the forests.

The improvement of the environment is presently connected with the chance of utilizing, on a regional scale, of geothermal energy, natural gas and other alternative energy sources for heating purposes.

In the Polish Carpathian basins there are stored about 100 km^3 of geothermal waters, containing thermal energy equivalent to about 700 million tonnes of standard fuel.

The most favourable conditions in Poland for using geothermal water for heating purposes exist. in the Carpathian subbasins of the Podhale region (between the Tatra Mountains and the Pieniny Klippen Belt Fig. 1). There geothermal waters with temperatures ranging from 35° up to 120°C, low mineralization and very high artesian pressure (about 25 atm at outflow) exist. The resource of geothermal water is estimated at over 10 km^3 and the thermal energy content equivalent to 60 million tonnes of standard fuel.

The results of a three-year experimental exploitation of Bańska IG-1—Biały Dunajec doublet show, that the method of producing and re-injecting of geothermal waters does not cause noticable corrosion of pipes nor disturb the hydrodynamic conditions, and has not affected the environment.

Studies done at the Experimental Geothermal Plant proved that geothermal energy can be used in a comprehensive way, i.e. for heating houses, driers, greenhouses and fish farming pools, as well as for balneology and recreation.

Economic assessments made by the authors and by specialists from Denmark, Great Britain, Italy and New Zealand show that in Poland the cost of receiving a given heat unit from geothermal waters can be much lower than from traditional energy carriers such as coal, lignite, natural gas or fuel oil.

All past assessments and results of experiments carried out in Poland, as well as the experiences of other countries exploiting geothermal energy, support the appropriateness of further geoenergetic development in Poland and in other Central and East European countries.

Geothermal waters that *occur* in the Podhale Basin are located between four national parks in an area of about 475 km^2, what is about 40% of the area of Dunajec River basin over the water dam in Czorsztyn. Geothermal waters in Podhale basin! observed via several wells, exist in the following formations: Eocene limestons, dolomites and Triassic limestones of the upper regle unit and in Liassic and Middle Triassic formations of central and lower regle units (South part of the thin). Presently. Eocene and Triassic waters of the upper regle unit (Bańska, Biały Dunajec, Poronin), and Jurassic waters of central regle unit (Zakopane) are exploited.

Geothermal waters of the highest, regle unit are utilized for heating purposes in the Experimental Geothermal Plant in Bańska Biały Dunajec to supply heat to the own building, greenhouse, wood drier, fishing pool, swimming pool and heating system which comprises about 350 detached buildings in Bańska Niżna Village. On the basis of obtained exploitation results. it was preliminary elaborated in EGP the programme of geothermal heating of the whole Podhale Region. This programme includes three stages. First of all, the heating of Central Valley (Biafy Dunajec) is planned, than – East Valley (Białka) and West Valley (Czarny Dunajec)

In order to carry out the above mentioned projects the company Geotermia Podhalańska S.A. was established. It prepares the projects as definite undertakings and endeavours to secure funds for their realization.

The Podhale Basin, rich in geothermal waters, is located on the North side of the Tatras and near Gorczański and Pieniński National Parks. The implementation of geothermal heating in Podhale will thus help limit the pollution in the above mentioned protected areas.

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