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THE DIFFERENTIATION OF TOURIST TRAFFIC IN THE WESTERN PART OF THE TATRA MOUNTAINS

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Abstract

Purpose. The aim of this research is to compare the number of tourists in selected tourist trails between the Polish (TNP) and Slovakian (TANAP) parts of the protected area in the Tatra Mountains. The research also aimed to determine if sensors are suitable for use in the study of tourist traffic in mountain areas.
Method. This article presents the results of a study that was focused on determining the number of tourists in an area based on data from tourist counters. The tourist counters were installed in the summer seasons from 2009 to 2011 in the subalpine and alpine belts of the western part of the Tatra Mountains. Detailed measurements of tourist traffic were taken within easily accessible high-mountain tourist trails. Additional detailed studies of relief transformations and related landform changes were also conducted within parts of these trails.
Findings. The research has shown that there is a significant differentiation in the intensity of tourist traffic between the Polish and Slovakian high parts of the Tatra Mountains. The volume of tourist traffic in the Polish part of the TNP is significantly higher.
Research and conclusions limitations. The research focused on tourist traffic in the highest parts of the western part of the Tatra Mountains.
Practical implications. The tourist counters are very useful in the management of hiking in protected areas. Tourist counters allow the measurement of tourist traffic in remote, high mountain locations where there are no other means of counting tourists in order to determine the distribution of tourist traffic.
Originality. This study is among the first to conduct research using tourist counters in Poland. The research measured the number of tourists in the alpine part of two national parks, Polish and Slovakian. An important aspect of this research is the fact that the data about tourist traffic numbers is linked to specific tourist trails in a high mountain area. This will allow for a comparison of the number of tourists at a later time.
Type of paper. Empirical research

Key words: tourism, automatic counters, high mountains, protected areas, TANAP, TNP.

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Introduction

One of the most important problems the Tatra National Park is facing currently is excessive tourist traffic on slopes within tourist footpaths [Skawiński 2006, pp. 25–28; Skawiński 2010, pp. 25–32]. When Poland and Slovakia signed the Schengen treaty on December 21, 2007, new opportunities for hiking arose, especially where the Polish and Slovakian tourist trails intersect, further increasing the amount of tourist traffic. An important issue in relation to the intensity of tourist traffic is the tourism capacity of a mountain area [Bogucka, Marchlewski 1982, pp. 17–66; Clivaz et al. 2004, pp. 230–235]. According to the World Tourism Organization, one of the factors affecting the tourism capacity of a given area is the resistance of the physical environment to destruction. This is especially important when comparing two mountain areas with different natural conditions, for example the les Monts Dore Massif (France) and the Tatra Mountains [Krzemień 1997, pp. 277–286; Clivaz et al. 2004, pp. 230–235].

Slopes within tourist trails, especially in protected areas, are places where most landform changes take place [Krzemień 1997, pp. 277–286; Rojan, Wałdykowski 2007, pp. 247–253; Buchwał, Fidelus 2008, pp. 14–24; Gorczyca, Krzemień 2010, pp. 228–242; Wałdykowski, Krzemień 2013, pp. 429–470]. The landform changes within tourist trails are associated with a combination of the effects of natural processes and of anthropogenic impact.

Management of protected areas requires an accurate analysis of the spatial distribution of tourist traffic, which can help prevent excessive degradation of the areas heavily used by tourists [Whinam, Chilcott 2003, pp. 339–351]. However, the determination of the number of tourists in high mountain areas is difficult. Therefore it is necessary to use methods which allow remote and continuous monitoring of tourist traffic. This is especially important in the most valuable natural areas exposed to significant transformations.

The aim of this paper is to compare the number of tourists on various tourist trails in the Polish (Tatra National Park – TNP; in Polish: TPN) and Slovakian (Tatranský Národný Park – TANAP) parts of the Tatra National Park. The study also aims to determine the suitability of the use of sensors in the study of tourist traffic in mountain areas.

Literature Review

The increasing number of tourists in the Tatras since the beginning of the twentieth century necessitated the development of a tourist infrastructure to make selected areas accessible to tourists [Baranowska-Janota et al. 2000, pp. 241–257; Baścik, Pociask-Karteczka 2006, pp. 87-107; Baranowska-Janota 2007, pp. 47–57]. A detailed description of the development of

tourism in the Kościeliska Valley since the eighteenth century is, for example, presented by M. Baścik and J. Pociask-Karteczka [2006, pp. 87–106]. An important moment in the development of tourism in the Tatra Mountains was the establishment of the Tatra Society in 1873 [Balon et al. 2006, pp. 65–92].

Since 1993, information about tourist traffic has been based on ticket sales [Pociask-Karteczka et al. 2007, pp. 271–279] (Fig. 1). Several studies, such as those of A. Płoszaj [1997, pp. 24–61]; J. T. Czochański and W. Szydarowski [2000, pp. 218–221], and J. T. Czochański [2002, pp. 284–403] have taken measurements of the spatial-temporal distribution of tourists based on direct measurements.

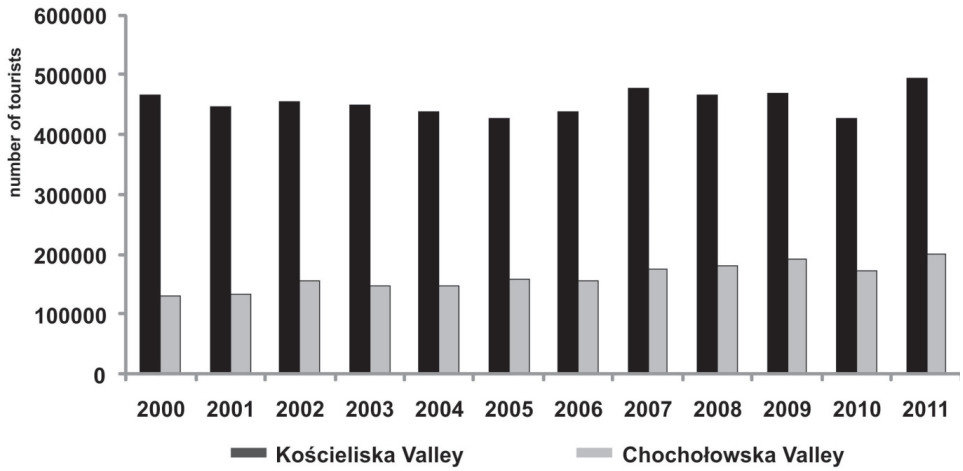

Figure 1. Tourist traffic in the Chochołowska and Kościeliska Valleys 2000–2011 (data based on ticket sales; data from the Chochołowska Valley also includes the number of tourists in the Lejowa Valley from June to October 2000–2011)

Source: Data from the Tatra National Park.

The early research, carried out August 5–7, 2004, focused on tourist traffic in the TANAP and the TNP simultaneously [Ładygin, Chovancova 2005, pp. 43–50; Šturcel 2006, pp. 109–114]. The measurements were repeated August 6–8, 2009. Determining the effects of anthropogenic degradation requires accurate estimates of tourist traffic [Bogucka, Marchlewski 1982, pp. 17–57; Leung, Lee 2003, pp. 53–56; Vistad 2003, pp. 363–368; Pociask-Karteczka et al. 2007, pp. 271–279]. The susceptibility of the slope surface to relief transformation within the tourist trails is dependent on a number of natural conditions in the area, such as types of cover and their saturation with melt and rainfall water. It is therefore important to determine the distribution of tourism in both the temporal and spatial contexts. For this purpose, both in Poland and worldwide, different methods are used for

estimating tourist numbers [Cole 2004, pp. 10–16; Melville, Ruohonen 2004, pp. 38–44; Ładygin, Chovancova 2005, pp. 15–87; Rupf-Haller et al. 2006, pp. 72–77; Shoji et al. 2008, pp. 286–295; Buchwał, Fidelus 2010, pp. 45–53]. Infrared sensors, cameras registering tourists, and sensors measuring the mechanical impact of tourists on the slope surface are all used for tourist traffic measurements [Cessford, Muhar 2003, pp. 242–245; Arnberger et al. 2005, pp. 317–327; Shoji et al. 2008, pp. 286–295]. G. Cessford and A. Muhar [2003, pp. 242–245] presented various methods of measuring tourist traffic in protected areas, including direct counts and measurements using various devices. For each of the methods, the authors presented positive and negative aspects of the measurement technique. Their research aids in selecting the proper methods of measuring tourist numbers based on the natural conditions of an area.

This data can also be used to show the relationship between the intensity of tourist traffic and certain meteorological conditions [Ploner, Brandenburg 2003, pp. 297–208].

Area of Study

The area of study is located in the western part of the Tatra Mountains. This area is protected by two national parks: the Tatra National Park (TNP – the Polish part) and the Tatranský Národný Park (TANAP – the Slovakian part). The measurements of tourist traffic were conducted in the following tourist trails in the Polish region: from the Chochołowska Valley to the Grześ summit (1653 m a.s.l.); from the Siwa Pass (1812 m a.s.l.) to the Gaborowa Pass (1938 m a.s.l.); and from the pass below Wołowiec to the Wołowiec summit (2064 m a.s.l.; Fig. 2). In the Slovakian region, measurements were conducted in the following areas: from the Łatana Valley to the Grześ summit (1653 m a.s.l.); from the Jarząbczy Wierch summit (2137 m a.s.l.) to the Raczkowa Czuba summit (2194 m a.s.l.); and from the Jamnicka Pass (1908 m a.s.l.) to the Wołowiec summit (2064 m a.s.l.).

The area of study is divided into two parts based on differing geological structures: the south is crystalline and the north is sedimentary. The crystalline part is composed mainly of granite and metamorphic rocks, such as gneisses, amphibolites, and crystalline schists. The sedimentary part is dominated by limestone, dolomites, and marls [Bac-Moszaszwili, Jurewicz 2010, pp. 62–63].

The areas are characterized by high natural values and a significant diversity in the number of tourists in different sections of the tourist trails. There are two large shelters located in the northern part of the area of study on the Ornak Glade (1100 m a.s.l.) and on the Chochołowska Glade (1146 m a.s.l.). The number of beds is 50 and 121, respectively. In the southern part of the study area, there are only two small chalets. The chalet in the Jam-

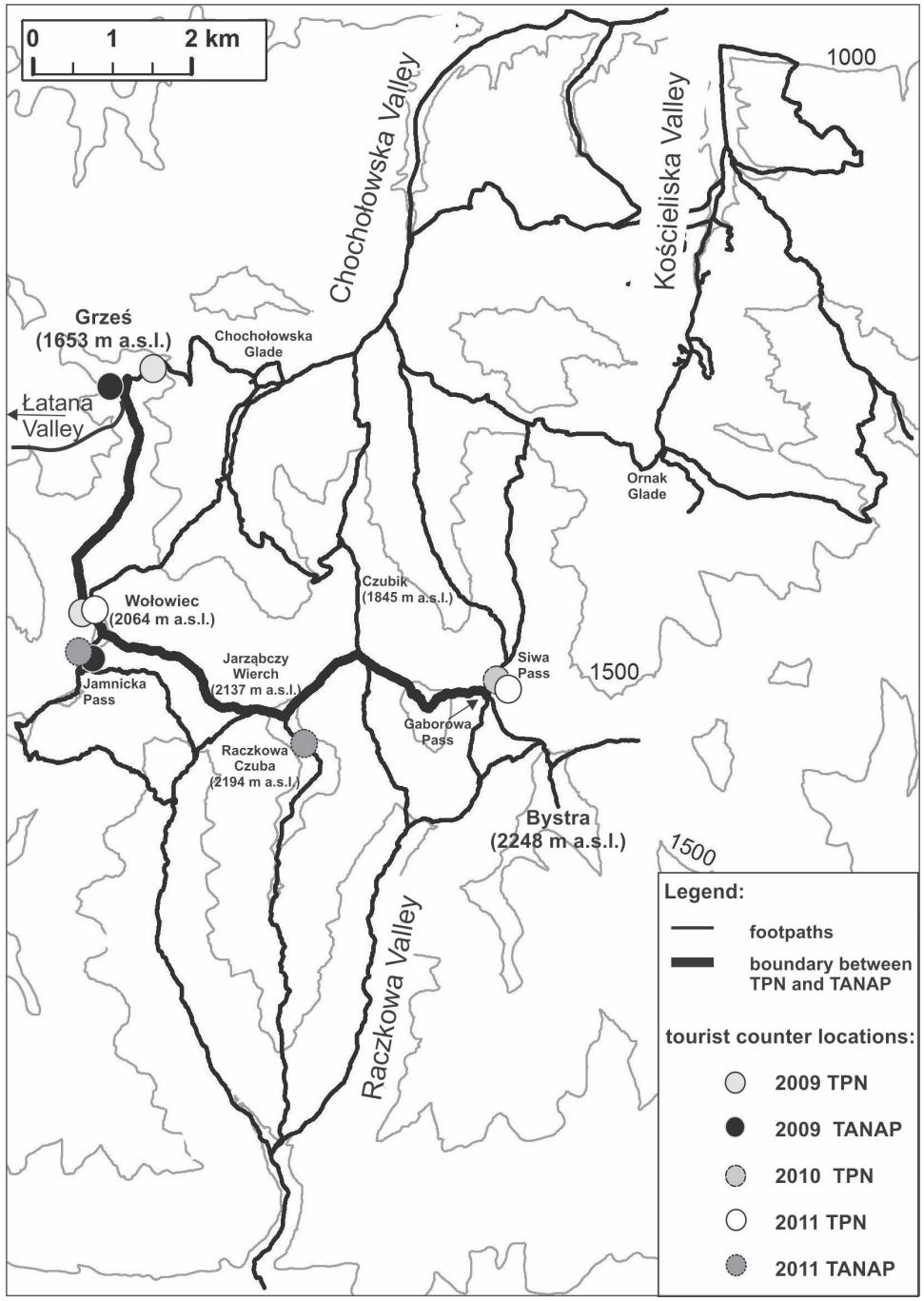

Figure 2. Location of automatic counters in the area of study (2009–2011)
Source: Author's work.

nicka Valley holds 20 people, and the chalet in the Raczkowa Valley holds five. However, in the Slovakian part of the area, there is a large campsite and several mountain hotels located near the entrance to the Wąska Valley.

Methods

Automatic infrared tourist counters from the Eco-counter company were used to measure tourist traffic (Photo 1). The passive infrared unit consists of a pyroelectric sensor and a logger (control unit). The system is weatherproof, and the integrated batteries should last for up to ten years. The average sensor range is four meters. The cables were buried and the logger was concealed using soil and rocks. One of the tourist counters was purchased by the author as part of her own research project, funded by the Ministry of Science and Higher Education (Nr NN 306 290 235), and the other counters were made available by the Tatra National Park. The sensors had to be installed so that they were concealed and secure in order to obtain accurate data, as well as to protect the devices from damage and theft.

Photo 1. A tourist counter used to measure tourist traffic
Source: Author's photo.

Automatic counters provide a continuous measurement of tourist traffic. The counters measured the traffic going in each direction separately. The tourist counters were installed in the summer seasons from 2009 to 2011 in the subalpine and alpine belts (see Fig. 2). The devices were installed depending on natural conditions in their respective locations (Photo 2 a, b). In the study area, the counters were hidden in rock fragments near the trails. Data was recorded hourly.

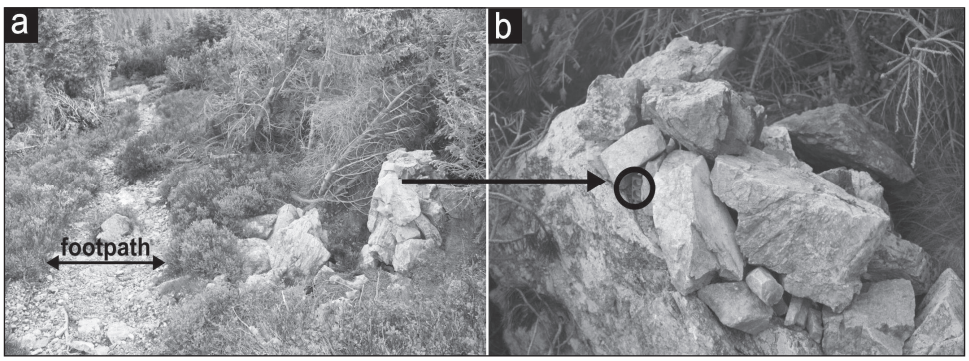

Photo 2 a, b. The locations of two counters in the study area: a) a tourist counter installed at the bedrocks near a trail from the Łatana Valley to the Grześ summit in the subalpine belt; b) a tourist counter installed within rock debris near the trail to the Grześ summit

Source: Author's photos.

This study compared the number of tourists in the Polish and Slovakian regions of the Western Tatra Mountains as well as the number of tourists in the forest and alpine belts. The comparison of the number of tourists in the forest and alpine belts was conducted on the basis of data obtained from tourist counters and from entrance tickets to the TNP. Data on tourist traffic in the Kościeliska Valley was provided by the TNP.

In order to explain the reasons for the temporal variability of tourist traffic according to meteorological conditions, rainfall data for the Chochołowska Glade, Ornak Glade, and Czubik slope was taken into consideration for 2009–2011. Data for the Chochołowska and Ornak Glades was obtained from the Institute of Meteorology and Water Management, PIB (PIB – the National Research Institute) and data for the Czubik slope (1746 m a.s.l.) was obtained from the author's own rain gauge, purchased as part of the research project. Usually, days with precipitation above two millimeters were counted as rainy days.

In the last stage of the research, a statistical analysis of the data was conducted through a t-Student's test and a correlation test.

Meteorological Conditions during Research

The average annual precipitation in the area of study from 2009 to 2011 was 1723 mm in the Chochołowska Glade and 1703 mm in the Ornak Glade (see Fig. 3). The most humid year was 2010. The annual sum of precipitation was 2163 mm in the Chochołowska Glade and 2165 mm in the Ornak Glade. The smallest annual precipitation occurred in 2011 (the sum of precipitation was 1300 mm and 1389 mm, respectively).

During the summer season (June–August), the annual sum of precipitation in the area of study reached approximately 450 mm and 600 mm [Łajczak 2006, pp. 19–35].

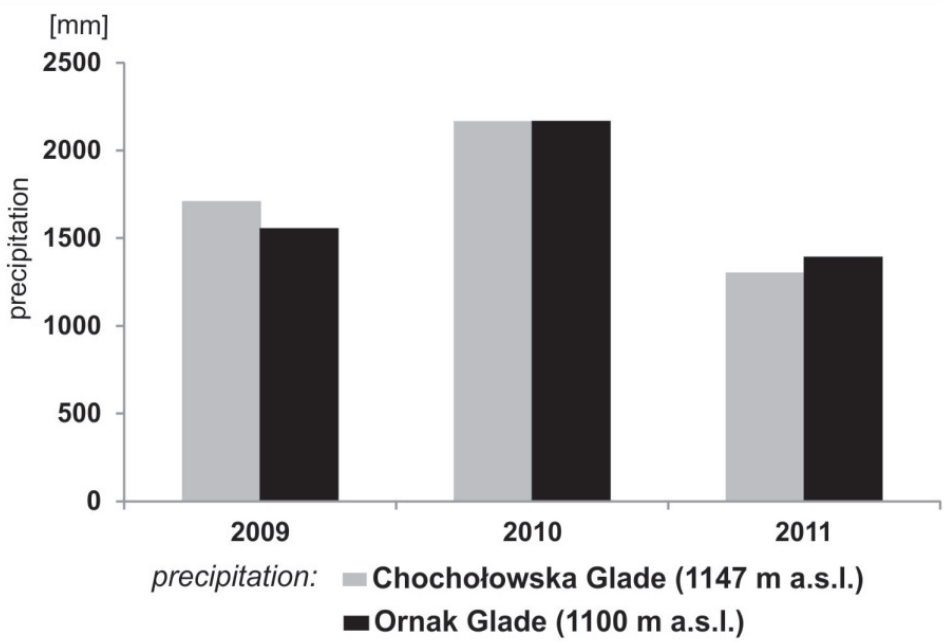

Figure 3. Average annual precipitation at the Chochołowska Glade (2009–2011)
Source: Data – Institute of Meteorology and Water Management, PIB.

Results

The number of tourists on the trails of the area varied drastically. There was a significant asymmetry in tourist traffic volume in the Polish and Slovakian regions. Studies based on these detailed measurements have shown that the largest number of tourists occurs on the trails from the Chochołowska Valley to the Grześ summit, and that the average daily number

of tourists is significantly higher on the Polish side. The average daily number of tourists on the footpath to the Grześ summit (1653 m a.s.l.) was 254 people on the Polish side, and only 53 people on the Slovakian side (Fig. 4).

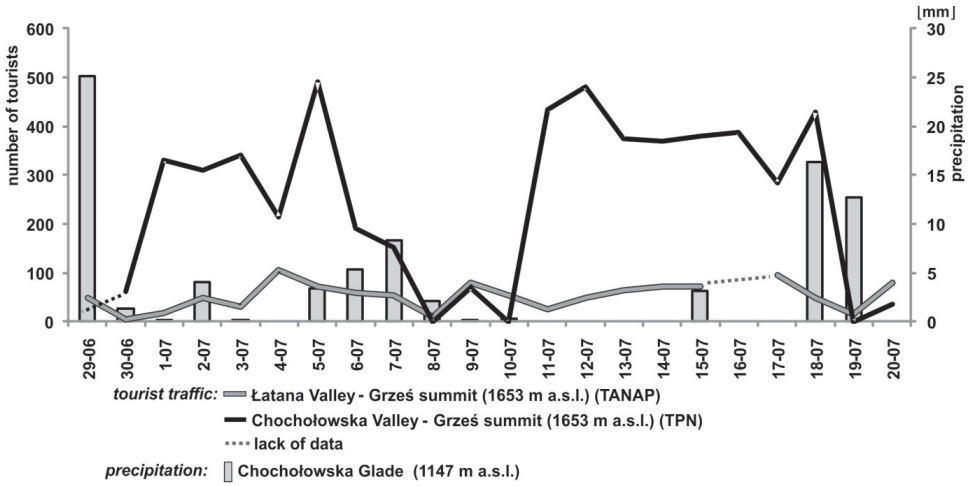

Figure 4. The number of tourists on trails from the Chochołowska Valley (TNP) and Łatana Valley (TANAP) to the Grześ summit, and the amount of precipitation in the area (June 29–July 20, 2009); the dashed line indicates a lack of data resulting from wrong sensor settings)

Source: Author's work.

The average daily number of tourists on the footpath from the Jamnicka Pass to the Wołowiec summit on the Slovakian side amounted to 16 persons. At the same time, the average daily number of tourists on the trail from the pass below Wołowiec to the Wołowiec summit was 133 persons, eight times more than on the Slovakian side (Fig. 5).

The number of tourists in the area varies as the weather conditions change, especially on days with precipitation. It is also dependent on the day of the week, with significantly higher numbers of tourists on the weekends, especially during so called "long weekends."

Between June 29 and July 20, 2009, the average daily number of tourists on the trail from the Chochołowska Valley to the Grześ summit on days with rain amounted to 244 people. On days without precipitation, the average number was 323 tourists. The average tourist traffic towards the Grześ summit from the Łatana Valley on the Slovakian side was only 48 people on days with rain and 70 people on days without rain. A similar differentiation can also be seen on the footpaths to the Wołowiec summit (Fig. 5).

There is a large disproportion in tourist traffic between the forest and high mountain belts. The majority of tourists in the Polish region are people

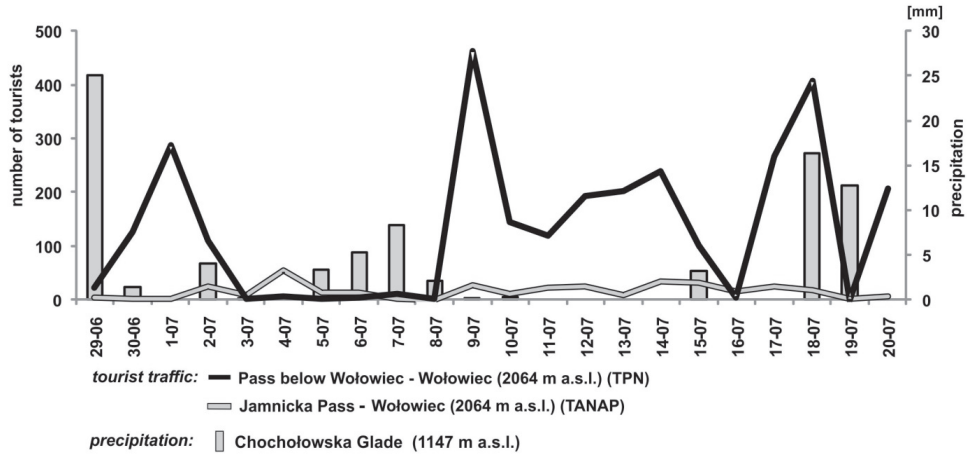

Figure 5. The number of tourists on the trail from the pass below Wołowiec and from the Jamnicka Pass to the Wołowiec summit (June 29–July 20, 2009)

Source: Author's work.

whose goal is to reach one of the mountain shelters. The average daily number of tourists from June 28 to October 21, 2010 was 2,308 tourists in the forest belt in the Kościeliska Valley. During the same period, the average daily number of tourists in the high mountain belt on the trail towards the

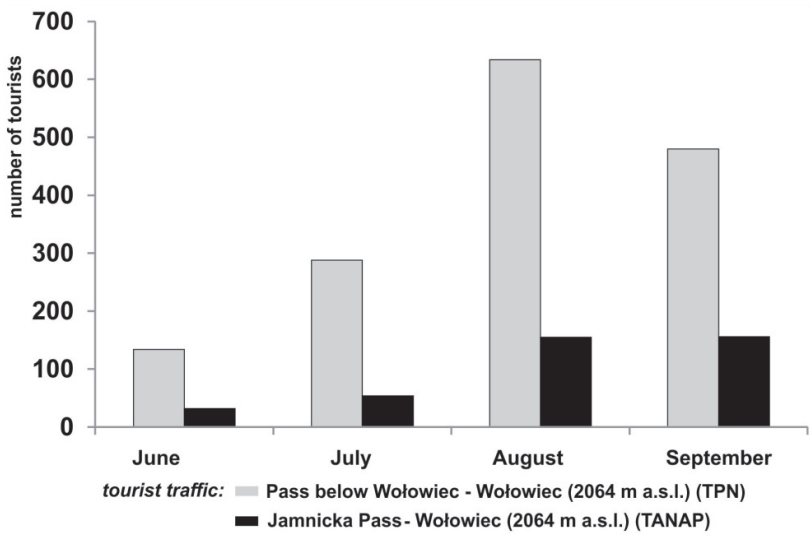

Figure 6. The average daily amount of tourist traffic on the trail from the pass below Wołowiec and Jamnicka Pass from June to September 2011

Source: Author's work.

Siwa Pass was 94. It is worth mentioning that despite this large disproportion in the number of tourists between the forest and alpine belts, the footpaths in the high parts of the study area are more sensitive to human impact. The natural environment above the timberline is also more vulnerable to relief transformations.

From June 15 to August 31, 2011, the average daily number of tourists was 406 people on the tourist trails from the pass below Wołowiec to the Wołowiec summit, and 93 people on the trail from the Jamnicka Pass to the Wołowiec summit (Fig. 2, 6). During rainy days (any amount of rainfall was taken into consideration), the counts were 244 and 53 people, respectively. On the Polish side, the tourist counter from the pass below Wołowiec to the Wołowiec summit was installed on May 22, 2011. The average daily number of tourists when the Slovakian part of the national park was closed was 79 (May 22–June 15, 2011; trails from the pass below Wołowiec to the Wołowiec summit). In the TANAP region, the tourist trails are closed to tourist traffic from November 1 to June 15 for the protection and regeneration of the natural environment.

A correlation test and t-Student's test were performed in order to show the dependencies of tourist traffic patterns within the Wołowiec summit from the TNP and TANAP sides, taking into account all research periods (Fig. 7, 8).

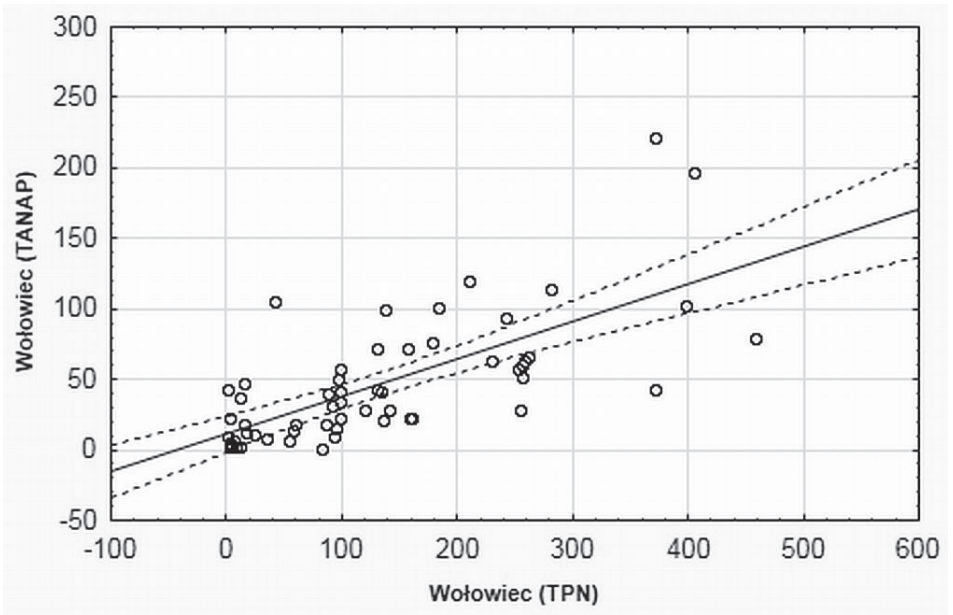

Figure 7. The correlation between tourist traffic on the footpaths leading from the Jamnicka Pass (TANAP) and the pass below Wołowiec (TNP) to the Wołowiec summit

Source: Author's work.

At a significance level of 5%, the correlation between the number of tourists in the TNP and TANAP within Wołowiec is positive (r = 0.7). The t-Student's test was performed for two independent samples (TNP, TANAP). At a 5% significance level, the test confirmed a difference between the average number of people in the analyzed tourist trails (p <0.00001). The average number of tourists for the tourist trails was 132 for TNP and 46 for TANAP (Fig. 8).

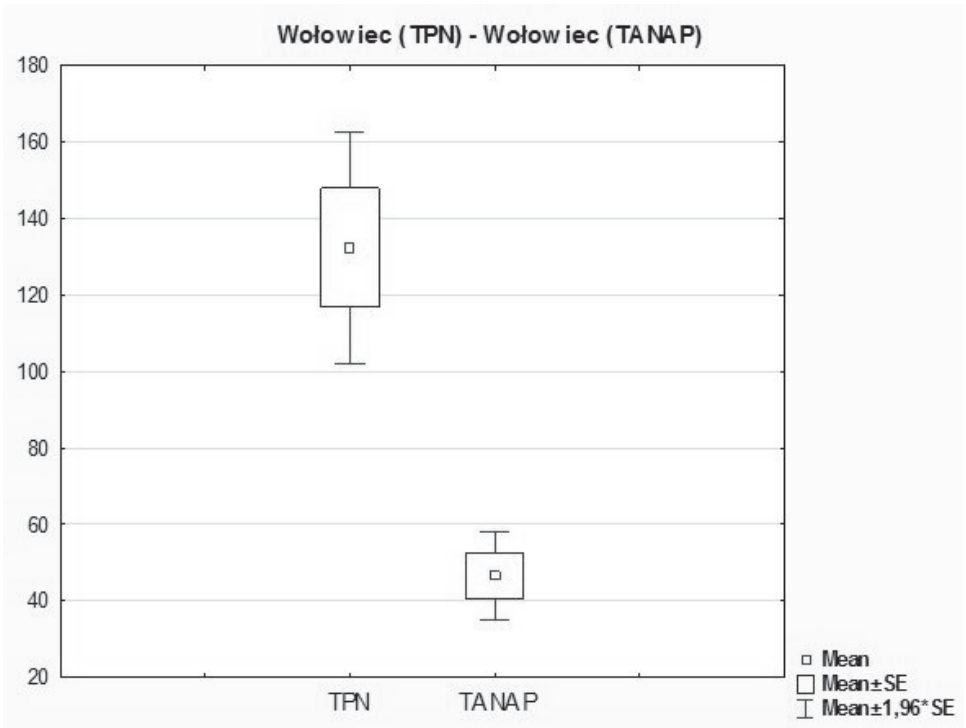

Figure 8. The diversity of tourist traffic on the tourist trails leading from the TNP and TANAP to the Wołowiec summit
Source: Author's work.

A disproportion in tourist traffic can also be observed on the trails from the Siwa Pass to the Gaborowa Pass and from the Jarząbczy summit to the Raczkowa Czuba summit (Fig. 9). The average daily number of tourists from July 18 to September 14 on the tourist trails from the Siwa Pass to the Gaborowa Pass was 133 persons. During the same period, the average daily number of tourists from the Jarząbczy Wierch summit to the Raczkowa Czuba summit was only 46 persons. This disproportion is also present on rainfall days (Fig. 9).

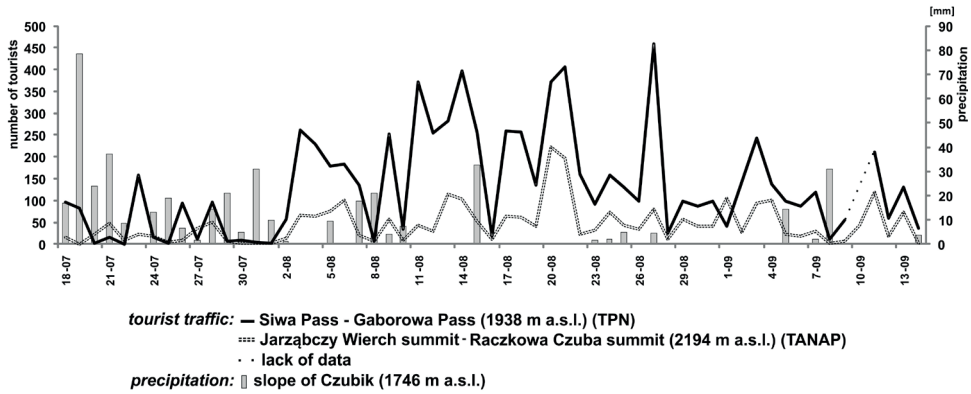

Figure 9. The number of tourists on trails from the Siwa Pass to Siwy Zwornik (TNP) and from Jarząbczy Wierch to Raczkowa Czuba (TANAP) from July 18 to September 14, 2011 and the precipitation at the Czubik summit

Source: Author's work.

Discussion

The automatic counters are very useful devices as they help to determine the distribution of tourist traffic in high mountain areas. The sensors on the tourist counters installed in high mountain areas require frequent and thorough checking. The sensors must be checked regularly because they are sensitive to disturbance.

It is possible to protect sensors in the forest belt in tree roots and trees or wooden stakes, as in the Babiogórski National Park [Buchwał, Fidelus 2010, pp. 48–49]. However, above the timberline it is harder to provide proper protection of the counters and therefore the sensors are more likely to become dislocated.

In the subalpine and alpine belts, the most proper protection of sensors is within rocks. However, the sensors should be located at least one meter above the footpath surface and at a distance of not more than one meter from the footpath. These specifications are determined by the four-meter measurement range of the devices. It is also not recommended to place the sensors within tall grasslands and shrubs because they may cause additional measurement errors during windy days. Exposing the sensors to intense direct sunlight can also cause errors.

Tourist counters are used in different protected areas in the world. For example, they are used in the Daisetsuzan National Park in Japan [Shoji et al. 2008, pp. 286–295] and in the Swiss National Park [Rupf-Haller et al. 2006, pp. 72–77]. However, research in these areas is conducted in specific tourist trails characterized by specific natural conditions over specific periods of time. Therefore, it is difficult to directly compare this data with data from other high mountain areas. When comparing data from distinct areas,

it is more accurate to compare annual, or even longer-term, data. Detailed comparisons require more specific and aligned studies.

Significant differences in tourist traffic between the TNP and TANAP may be due to the much larger area of the Tatra Mountains on the Slovakian side and also the smaller total population of Slovakia. The larger area of the Slovakian Tatras causes a smaller concentration of tourist traffic, which in turn may be the cause of the large asymmetry between the studied tourist trails.

There is also a significant disproportion in tourist traffic between the forest belt (especially in the valleys) and the alpine belt. Despite the significantly smaller tourist traffic intensity, the high mountain part of the area is more susceptible to human impact due to natural factors.

The annual intensity of tourist traffic in the entire Tatra Mountains is very large compared to other mountain areas. The average annual number of tourists in the TNP is about 2.5 million. In the alpine national parks, the average number of tourists is 700,000 people per year [Pociask-Karteczka et al. 2007, pp. 271–279].

The mountain areas in Switzerland cover an area of 29,000 km^2, and the average annual number of tourists is 222 persons per km^2. The mountain areas in France cover 60,000 km^2 and the average annual number of tourists is 916 persons per km^2. In Poland, the mountain areas are 9,380 km^2 and the number of tourists is much larger at 3,955 persons per km^2. In turn, the area of the Polish Tatra Mountains is 211 km^2, and the average annual number of tourists is 12,038 persons per km^2 [Czochański, Szydarowski 2000, pp. 207–228]. These comparisons show that there is a significant number of tourists in the Tatra National Park.

Conclusions

There is a considerable spatial differentiation in tourist traffic in the Western Tatra Mountains and a disproportion between the Polish and Slovakian parts of the national parks. The Polish part of the mountains receives a larger amount of tourist traffic. The largest concentration of tourist traffic above the timberline in the area of study is within the tourist trails from the pass below Wołowiec to the Wołowiec summit and within the footpaths to the Grześ summit.

There is also a significant disproportion in tourist traffic between the forest belt and the alpine belt, with the majority of tourists staying in the valleys. Despite this fact, the high mountain part of the area is more exposed to human impact.

Overall, tourist counters are very useful tools for monitoring tourist traffic in remote, protected areas. However, their installation in high mountain areas, especially above the timberline, requires detailed planning and precise control over sensor location, as well as ongoing verification of sensor placement.

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ZRÓŻNICOWANIE RUCHU TURYSTYCZNEGO W TATRACH ZACHODNICH

Abstrakt

Cel. Celem badań jest porównanie liczby turystów w wybranych odcinkach ścieżek w polskiej (TPN) i słowackiej (TANAP) części Tatr Zachodnich. Celem badań jest również określenie przydatności czujników w badaniach ruchu turystycznego w obszarach górskich.
Metoda. Artykuł prezentuje wyniki pomiarów ruchu turystycznego uzyskanych na podstawie czujników ruchu. Czujniki ruchu instalowane były w sezonach letnich w piętrach subalpejskim i alpejskim w Tatrach Zachodnich, w latach 2009-2011. Badania prowadzono w łatwo dostępnych odcinkach ścieżek zlokalizowanych w części wysokogórskiej Tatr Zachodnich. Ponadto przeprowadzono również badania przekształceń rzeźby w analizowanych odcinkach ścieżek.
Wyniki. Badania wykazały, iż istnieje znaczne zróżnicowanie intensywności ruchu turystycznego pomiędzy polską i słowacką częścią Tatr Zachodnich. W części polskiej badanego obszaru ruch turystyczny jest znacząco większy.
Ograniczenia badań i wnioskowania. Badania dotyczyły pomiaru ruchu turystycznego w najwyższej części Tatr Zachodnich.
Implikacje praktyczne. Czujniki ruchu odgrywają istotne znaczenie w zarządzaniu turystyką pieszą w obszarach chronionych. Czujniki ruchu pozwalają pomierzyć liczbę turystów w trudno dostępnych, wysokogórskich obszarach gdzie trudne są bezpośrednie pomiary rozmieszczenia ruchu turystycznego.
Orginalność. Pomiary ruchu turystycznego z zastosowaniem czujników ruchu to jedne z pierwszych badań w Polsce. Badania pozwoliły na określenie liczby turystów w polskiej i słowackiej części Tatrzańskiego Parku Narodowego. Ważnym aspektem badań jest fakt, iż pomiary odnoszą się do konkretnych odcinków ścieżek w części wysokogórskiej. Wyniki badań będą mogły zostać porównane z pomiarami ruchu turystycznego prowadzonymi w późniejszych okresach czasu.
Rodzaj pracy. Badania empiryczne.

Słowa kluczowe: turystyka, automatyczne czujniki ruchu, góry wysokie, obszary chronione, TANAP, TPN.