CLIMATE VARIABILITY AND ITS IMPLICATIONS FOR WINTER MOUNTAIN TOURISM IN THE PRAHOVA VALLEY-POIANA BRAŞOV AREA

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ABSTRACT
The paper presents the relationship between climate variability and available indicators of tourist accommodation capacity and demand in the mountain resorts of the Prahova Valley – Poiana Braşov area, in the light of current climate warming trends. Weather observations made at three met stations (Predeal, Sinaia and Omu Peak) over a lapse of 46 years (1961-2007) looked at variation trends in the main climatic elements relevant for tourism activities in winter (air temperature, atmospheric precipitation and snow cover) and their statistical significance. The study also aimed to assess the way in which local hotel managers perceive current winter climate variations and their impact on tourism. To this end, a questionnaire was circulated in February 2008, within the major accommodation structures of the study region.

KEY-WORDS: winter, mountain, tourism resorts, ski, indicators, survey.

INTRODUCTION

A highly topical issue worldwide and in Europe as well, concerns the impact of climate variability on the economy, in general and on tourism, in particular. Sustained interest in studying climate evolution trends has lately been noticed in the use of scenario-based climate modelling and estimation of their consequences for sensitive economic sectors like agriculture, energy, health-care and, last but not least, tourism. At the end of 2007[1], the UNTWO[2] Secretary General (Francesco Frangialli) declared the two major global problems related to tourism sector, the impact of climate change and the alleviation of poverty. As a result, a number of studies and projects on the subject have been produced in the world and particularly in Europe. Most of them refer to Western Europe, but more recently, as the European Union has enlarged towards the Central and Eastern parts of the Continent (among which Romania[3]), their coverage has widened.

Based on meteorological observations in the 1961-2007 period, air temperature in Romania during the 20th and early 21st centuries rose by some +0.5ºC (Busuioc, 2008). Against this warming background, the Romanian Carpathians tend to become warmer, the frequency of extreme negative days tends to decrease and characteristic thermal winter days become fewer. At the same time, the incidence of snow cover days is significantly reduced. These cumulated climate variability conditions in the mountain region entailed losses for the tourism operators focused on

[1] UN Conference on Climate Change (Bali, Indonesia, 12th December, 2007)
[2] United Nations World Tourism Organization
[3] http://www.clavier-eu.org/clavier/

winter sports offer in most of Romania's mountain resorts. Neither did Valea Prahovei - Poiana Braşov area, which covers the largest ski domain in the Romanian Carpathians[4] and holds an important tourist infrastructure, escape these negative effects.

Ski tracks are currently found at altitudes of 800-2,000 m, but best conditions for practicing this sport exist between 1,500 and 2,000 m. However, since most tracks in the Prahova Valley – Poiana Braşov area occur at 800-1,500 m altitude, they appear to be particularly sensitive to winter variations of the temperature and precipitation regime, given that a general warming process in the mountain region is already underway.

Looking at the implications of climate variability in the cold season for winter sports (ski in particular), the following aspects have to be taken into account:

- Winter climatic conditions with direct bearing on the favourability of practicing winter sports in a mountain region;
- Winter climate variation trends from November to April;
- Characteristic features of the ski domain, specific winter sports tourism infrastructure, tourism accommodation capacities in the main mountain resorts of the study area;
- Winter tourist demand in the Prahova Valley – Poiana Braşov mountain resorts;
- Perception of investors and of local authorities on climate variability and its impact on winter tourism.

DATA

In order to analyse the influence of winter climate variability on tourism activities in the cold season, with emphasis on skiing, we resorted to the monthly temperature, snowfall and snow cover data available at Sinaia (1,510 m) and Predeal (1,090 m) weather stations. These are the most relevant data of climate favorability for practicing winter sports on low-altitude tracks. For comparison's sake and for the accurate reflection of the situation at 1,600 m, the Omu Peak weather station (2,504 m) records proved to be the most relevant ones. Noteworthy, Postăvaru weather station, which is the most faithful reporter of winter climate conditions at Poiana Braşov resort, has not been analysed by us because its observation series being too short (<30 years), representative data are missing.

Winter climate variability was followed from November through to April, spanning the winter period proper and the ski season (December-March) in the studied mountain area.

The analysis of tourism activities had in view the monthly values of two relevant tourism indicators over November-April (2000-2006): overnights and occupancy rate index (significant for the study area in which new tourism accommodation structures were opened, or older ones were restructured and updated over 2002-2006; this means that the tourism accommodation base of certain resorts within our study interval was pretty dynamic.

RESULTS

[4] It concentrates over 50% of the optimum ski domain and 1/3 of the overall accommodation capacity in the Romanian Carpathians.

1. CLIMATIC FAVOURABILITY AND VARIABILITY

A region is assumed to be climatically favourable for practicing winter sports provided a series of conditions are met (INCDT, 2003): no extreme temperature values; low frequency of snowstorm days; few strong wind days (>16 m/s) which carry the snow to higher altitudes; average snow cover duration >120 days/year; snow depth >20 cm; high frequency of air frost days ensuring snow cover persistence.

A synthetic picture of winter sports climatic favourability in the studied mountain regions is given in Table 1. Lots of studies have already been published on winter tourism activities in alpine countries boasting winter sports traditions (Breiling *et al*., 1997; Elsasser and Bürki, 2002; König and Abegg, 1997). What they all outline is that winter tourism is economically viable provided there is a sufficient quantity of snow. A ski resort is considered to be viable if in 7 out of 10 winters there is a 30-50 cm snow cover at least for 100 days between December 1 and April 15 (Bürki, 2000; Elsasser and Bürki, 2002).

Table 1. Reliable climatic conditions for winter sports in the studied mountain area over the November-April interval

Favorable winter sports climatic indicators	Omu Peak*	Sinaia	Predeal
Extreme temperatures (T_{min}) (ºC)	-12.7	-7.7	-7.1
Extreme temperatures (T_{max}) (ºC)	-2.5	5.0	6.7
Annual snow pack duration (days)	281	191	179
Mean number of days with snow depth >20 cm	136	94	88
Mean snow onset date	19.IX	24.X	29.X
Mean snow melt date	25.VI	30.IV	27.IV
Mean number of days with $T_{min} \leq 0$ºC	179	146	154
Mean number of snowstorm days	38	8	6
Mean number of strong wind days (>16 m/s)	90	11	3

*Weather station representative for climatic conditions in the alpine realm. Data source: Data calculated from the National Administration of Meteorology Archives (1961-2007).

The thermal factor exerts restrictions on winter tourism, due both to the high frequency of positive deviations (maximum incidence 60-80% in the 1970s) and especially to their amplitude, high values having been recorded largely after 2000 at all weather stations of the study area. The most striking positive deviation over the 1961-2007 period was of +2.6ºC at all the three weather stations in the winters of 2000-2001 (Omu Peak and Sinaia) and 2006-2007 (Predeal, respectively).

The high incidence of extreme phenomena such as heat waves* was more frequent and intense in the studied area, mostly after 1989-1990 and more especially after 2000, when deviations lasted +2…+3 times the standard deviation value, or even higher (Cheval *et al*., 2003).

* Heat waves are defined as at least 6 consecutive days with maximum air temperatures by 5ºC higher than the multiannual mean over the studied period of meteorological observations (Source: Stardex - *Statistical and Regional Dynamical Downscaling of Extremes for European Regions*).

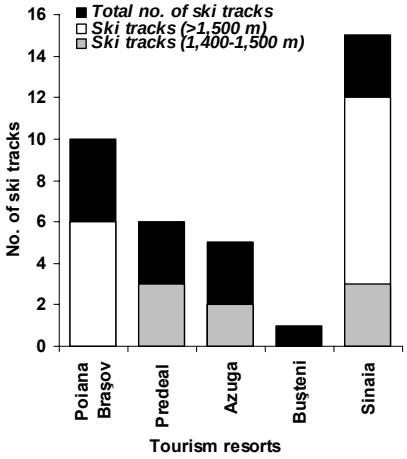

Fig. 1. Ski slopes distribution by altitude in the Prahova Valley-Poiana Braşov area
(Source: INCDT, 2003).

To compensate for the effects of warming on the ski tracks snow cover, artificial snow devices could be used, especially downslope and in the junction area of several tracks. However, heat limits the functionality of these devices, which become operational only at air temperatures of 3-5ºC below freezing point. In the warmest winters (2000-2001 and 2006-2007) with temperature deviations higher that 2ºC these installations failed to function in most of the study-area resorts.

The precipitation factor is essential in forming the snow cover, indispensable for winter tourism. The number of snow days is of overriding importance in analyzing climate variability during the ski season. After 1989, this climate variable showed a visible falling trend from November through to April at all the weather stations studied. Variation rates were an indication of significantly deficitary snowfalls, especially on low-altitude ski tracks (-68 days/46 winters at Sinaia and -58 days/46 winters at Predeal) comparatively with tracks at over 2,000 m altitude, where variation rates were somehow more depleted (-48 days/46 winters at Omu Peak). In the 1961-2007 period, marked inter-decennial variability was noticeable, suggesting a visible drop in snowfall frequency in the 1990s against previous decades: by 18-27% (Omu Peak), 34-53% (Sinaia) and 26-41% (Predeal).

The number of snow cover days over the November-April interval would generally stay within multiannual values, without statistically significant trends in terms of the length of the observation series analysed. Thus, it was only at Sinaia that the number of snow cover days tended to decrease slightly, with a mild increasing tendency in the ski area north of the study perimeter (Predeal) and at over 2,000 m altitude. It follows that the variation rates in the study period were quite insignificant, with increases and decreases of snow cover days (+3 days/46 winters at Predeal and +2 days/46 winters at Omu Peak and -2 days/46 winters at Sinaia, respectively). In this case there is little inter-decennial variability, with increases by 1-77% (Omu Peak) and falls by 4-14% (Sinaia Cota 1,500 m) or 4-12% (Predeal), after 2000 compared to the previous decades.

By number of days with snow depth >20 cm, most ski tracks in the forest belt (<1,800 m) experienced a particularly warm winter in 2000-2001, coming second in the classification of snow-deficient years, hence a snow cover unsuitable for winter sports (20 days at Sinaia and 24 days at Predeal as against 123 days at Omu Peak, over the November 2000 – April 2001 interval). But for all that, variation trends over

1961-2007 were very much significant in statistics, at any of the weather stations studied.

Previous studies of snow cover variability in Romania (e.g. Bojariu and Dinu, 2007) showed a general downward trend of the sum of snow cover thickness registered in the middle and at the end of the winter period, due to changes in the general atmospheric circulation induced by the Carpathian Chain. However, the beginning of winter was marked by an increasing trend. Statistically significant decreases in snow cover thickness were recorded only in the Apuseni Mountains and in the north-north-east of the Eastern Carpathians, without any notable variations occurring in the Southern Carpathians, either in point of increases or decreases. And yet, there were some suggestive signals of incipient changes in the variation of the snow regime within the Prahova Valley-Poiana Braşov mountain area, to the effect of a smaller annual snow cover interval registered at Sinaia and Predeal stations (at a rate of 27-30 days/46 winters). In the alpine realm (Omu Peak), the snow cover continued to persist from one year to the next, because altitude control prevents significant positive temperature deviations liable to drastically reduce the snow cover interval. Nevertheless, the presence of a snow cover capable to sustain winter sports was seriously affected by depleted snowfalls over November-April.

Looking at the implications of the two climate factors (temperature and precipitation) it appears that there is no special synchronism between the incidence of warm or very warm winters and snow-deficiency (Table 2). Despite it, the link between the two climatic variables engenders an antithetic and inverse correlation with values of -0.71 (Omu Peak) and -0.97 (Predeal).

In view of it, the warmest winter in the Prahova Valley-Poiana Braşov mountain area was 2000-2001, in both forest and alpine belts, while 2006-2007, considered to have been the warmest on record in Romania, ranked second only at the weather stations situated below 1,600 m, but occupying the fifth position at Omu Peak (Table 2). The warm 2000-2001 winter influenced also snow cover thickness (45 cm on average) on ski tracks at <1,500 m altitude, from November through to April. The snow pack in 2006-2007 was thicker than in the previous warm winter, but average decadal depths were generally below multiannual values.

Table 2. The warmest 10 winters and the most snow-deficient 10 winters (1961-2007)

Position	Omu Peak (2,504 m)		Sinaia (1,510 m)		Predeal (1,090 m)	
The warmest 10 winters (°C)						
1.	2000-2001	-5.4	2000-2001	0.6	2000-2001	1.0
2.	1993-1994	-6.7	2006-2007	-0.1	2006-2007	0.9
3.	1971-1972	-6.7	1989-1990	-0.6	1976-1977	0.2
4.	1989-1990	-6.8	1965-1966	-0.8	1965-1966	0.2
5.	2006-2007	-6.9	1982-1983	-1.0	1982-1983	0.0
6.	1978-1979	-6.9	1993-1994	-1.0	1993-1994	0.0
7.	1965-1966	-6.9	1974-1975	-1.2	1969-1970	-0.2
8.	1976-1977	-6.9	1997-1998	-1.3	1989-1990	-0.3
9.	1997-1998	-7.0	1978-1979	-1.5	1974-1975	-0.5
10.	1988-1989	-7.1	2003-2004	-1.6	1971-1972	-0.5
The most snow deficitary 10 winters (cm)						
1.	1989-1990	14	2000-2001	38	2000-2001	43
2.	2000-2001	17	1973-1974	55	1976-1977	43

3.	1984-1985	21	1977-1978	58	1970-1971	58
4.	1990-1991	28	1991-1992	61	1993-1994	72
5.	1992-1993	33	2001-2002	63	1977-1978	72
6.	1991-1992	34	1989-1990	73	1963-1964	79
7.	1986-1987	36	1966-1967	80	1989-1990	88
8.	1970-1971	43	1982-1983	86	1982-1983	88
9.	1983-1984	47	2006-2007	90	1971-1972	94
10.	1977-1978	51	1965-1966	103	1962-1963	100

Source: Data calculated from the National Administration of Meteorology Archives, over the November-April interval.

For all that, the winter 2006-2007 was a warm one, of reference for our study, in terms of correlations with the tourist indicators specific to mountain resorts in the Prahova Valley – Poiana Braşov area, available only for the 2002-2006 interval. That winter being warm (deviations by some 2ºC from the multiannual mean) and coupled with a belated snow cover onset and with its melting much earlier than usual, especially in the Prahova Valley – Poiana Braşov tourist resorts (mid-March compared to May at Poiana Braşov) entailed significant losses for tourism operators.

2. VARIABILITY OF WINTER TOURISM INDICATORS

In order to analyze the connection between tourism variability and climatic indicators in the winter season, specialist studies[5] used indicators such as: number of transports to winter sports resorts; number of cable transports, activity of artificial snow installations (König and Abegg, 1997), number of overnight stays in the tourist season, share of tourism in the GDP (Breiling, 1998), number of overnight stays and average stay (Bigano *et al*., 2005). Based on available data, we looked into the monthly average of overnight stays and, as a result of the fairly dynamic changes in the accommodation infrastructure over the past few years (greater accommodation capacity and structural modification of the type of accommodation units) we deemed that the occupancy index was relevant, too.

Monthly numerical evolution of overnights in the winter season shows significant differences among the resorts (Fig. 2). The peak of the winter season (December – January) could be distinguished more and more clearly at Poiana Braşov, a resort offering better winter sports facilities; at Sinaia there are no value differences in the winter season months; Predeal marked a gradual rise in the overnight stays total (from one season to the other, due perhaps to extended accommodation capacity (e.g. 2003-2004 – Figs. 2, 3); no seasonal differences in Buşteni either by the end of the analysed period. The biggest fluctuations in overnights registered Azuga, also a highly specialized winter sports resort, that benefited from notable investments over the 2002-2006 period, rising its occupncy rate and improving its ski facilities[6].

No doubt that December was the month with the utmost demand for overnights in all resorts, people choosing to practice winter sports and spend their

[5] Elaborated especially for traditional ski areas in the Alps.

[6] Azuga was not included in the overnight stays graph because of the irrelevance of its profile at this scale, it nevertheless is mentioned under occupancy rate variability, which is quite similar to overnights in the case of this resort.

Christmas and New Year's Eve[7]. Lately, it was MICE[8] tourism and especially its component that developed, moreover so as our study resorts lie close to the big urban agglomerations, among which the City of Bucharest. Many overnight stays registered also January, while February (a full winter sports month) was more uneven in this respect, values differing from one year to the next (within one and the same resort, and from one resort to the other) (Fig. 2).

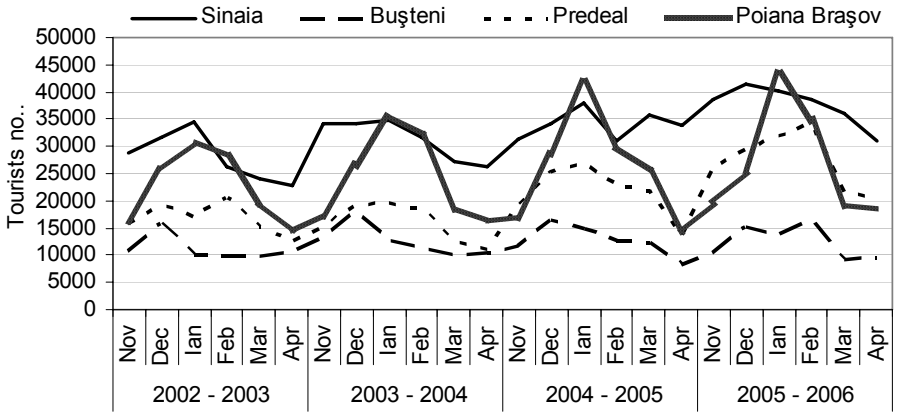

Fig. 2. Overnight stays in the main winter sports resorts in the Prahova Valley-Poiana Braşov mountain area, during the winter season (Data source: National Institute of Statistics).

Thus, February 2006 stood out by increased demand for overnights at Buşteni, Predeal and particularly at Azuga (Fig. 3), some elevated overnights values being registered also in Sinaia and Poiana Braşov resorts; this is the more remarkable as in the previous winter, February had registered decreases in all our study resorts.

The monthly evolution of the occupancy rate index shows an obvious secondary winter season peak in February 2006, against January in all the four resorts. However, January 2005 was a record high month in Poiana Braşov and Azuga, with significant values not very different from December 2004 and February 2005 in Sinaia and Predeal; the opposite in Buşteni, where the occupancy rate of January 2004-2005 winter season showed a marked decrease. February 2004 had high values at Sinaia, Predeal and Poiana Braşov, but not at Azuga. In the case of Buşteni resort, some decreases could be noticed in two consequtive winter seasons (2002-2003 and 2003-2004) after the peak December month (decreases in January also occurred in the 2004-2005 and 2005-2006 seasons), the reason could be that the resort is not a typical ski destionation (like Poiana Braşov or Azuga, for instance), it still depending to a great extent on the opening of student camps.

February 2003 was a peak winter season at Azuga and Predeal, but less so at Poiana Braşov. As a matter of fact, January and especially February would be more relevant for our analysis than the month of December because it registered a higher demand especially in ski resorts (e.g. Azuga).

[7] The majority begin on December 30.
[8] Meetings, Incentives, Conferences, Events.

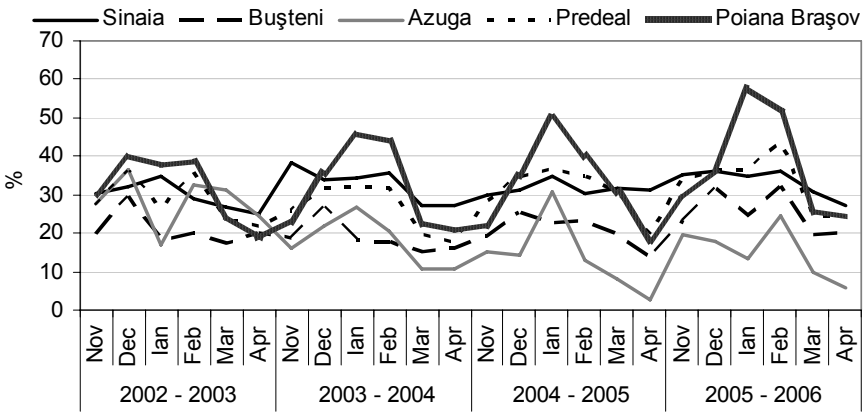

Fig. 3. Occupancy rate in the main winter sports resorts in the Prahova Valley-Poiana Braşov mountain area, during the winter season (Data source: National Institute of Statistics)

The absence of monthly statistical data for longer time spans (tourism monthly data are available since 2002) makes almost impossible a regression analysis for the two types of indicators. Moreover the lack of these data for significant winter seasons in terms of climate variability (for the 2000-2001 season, considered to be one of the warmest in the meteorological observation range for the Prahova Valley – Poiana Braşov area), as well as the absence of a detailed tourism marketing study of the motivation for winter tourism demand in the area, prevented us from making clear-cut assessments of the influence of climate variables on tourist activities in Buşteni, Sinaia, Azuga, Predeal and Poiana Braşov resorts. In the absence of data and of appropriate studies, tourism units managers (considered the most important stakeholders of tourism activities in the area) were asked to fill in a questionnaire which tried to emphasize the role of winter climate conditions on tourism demand in the region.

3. THE PERCEPTION OF TOURISM UNITS MANAGERS REGARDING THE IMPACT OF CLIMATE VARIABILITY ON WINTER TOURISM

The questionnaire administered over January 20 – October 2, 2008 under the European CLAVIER[9] project, part of Framework Programme 6, was elaborated with a view to getting a better insight into the connection between the two types of indicators in the resorts in which the monthly statistical data had been analysed. The 50 questionnaires were returned by 26 respondents[10]. Beside the general identification data requested from accommodation units (location, comfort level, opening year) the questionnaire include another 14 questions. There were 12 closed questions requesting estimations on the proportion of demand segments (using a four-value Lickert type scale: <25%, 25-50%, 50-75% and >75%), asking opinions onclimate variability aspects (with variants ranging from 3, 4 or 6) and 2 open questions on the way in which climate change influences the activity of accommodation units and of the resort they are located in.

[9] Climate Change and Variability: Impact on Central and Eastern Europe (CLAVIER), www.clavier-eu.org.

[10] The response rate was considered sufficient, given the high degree of representativity of respondent units in terms of their identification criteria.

With regard to the first part of the questionnaire requesting answers to the importance of the winter season and of winter sports tourism in the Prahova Valley – Poiana Braşov area, 66% of the units responded that the winter season was a very important one, accounting for 50-75% of arrivals over the year. In terms of occupancy rate, December, January and February designated almost by the same respondents as having the highest occupancy rate over the year. However, the most comfortable units (4 star hotels) in Sinaia and Braşov put the proportion of winter tourists to under 25% of all arrivals year. As for the average stay of winter tourists, 35% of the respondents indicated 2-3 days, 45% 3-5 days, the majority of tourists being week-end tourists (2 days), or ≥ 3-day tourists, spending either their leisure time and/or practicing winter sports, or being business tourists. Some 10% of the respondents (big olympic complexes and sportive clubs e.g. in Poiana Braşov) indicated a 7-14-day sojourn.

The ratio between business tourists and holiday-makers in the winter season is in favour of the former category (50-75%); that is in nearly one-third of the interviewed units, which means that a significant number of important units, largely those in Sinaia and Poiana Braşov opted also for other tourist segments, basically for business tourism - MICE also in the winter sports season. However, more than 50% of the interviewed units proved to be significantly vulnerable (estimating business tourists at <25%) or moderately vulnerable (under 1/3 of the respondents putting business tourists at 25-50%) to winter climate variability.

The answers to the second part of the questionnaire, referring to the importance of climate variability for winter sports tourism in mountain resorts show that 35% of the accommodation units considered that ski tracks played a great and very great role (influencing 50-75% and over 75%, respectively of tourist arrivals during the winter season). These 2 and 3 star units are usually big-sized, having been built before the communist era. Therefore, they have a tradition of catering for this tourist segment and have not the modern facilities (conference halls) of newer 3-4-star hotels oriented particularly to business tourism. Therefore they would seem more vulnerable to winter climate variability. According to 95% of the respondents, snow was an essential prerequisite for the opening of the winter tourism season; 62% viewed snow cover to have an overriding importance for winter tourism and occupancy rate in their units, while 35% did not perceive it particularly relevant. These answers suggest that in general, the studied resorts are very vulnerable to the quantity of snow and by extension to climate variability. Moreover, more than 80% of the questioned units considered that these elements impacted their wintertime activity; 15% did not notice any climate change.

Answers to the open question as to the manner in which climate change bears on tourism activity were pretty diverse, but the majority read that the absence or diminution of the snow cover led to fewer arrivals and overnight stays, or even to cancellations. Tourist units, located close to ski tracks, hence more dependent on the practice of winter sports, gave extensive responses, with highlight on the winter of 2006-2007, when warm weather had a negative effect on their activity, mostly in December-January, a period that represents important additions to their revenue. It is worth mentioning that 70% of the respondents viewed global warming of great consequence and that it should be given due consideration by development strategies for mountain resorts.

The answers given by the managers of tourist accommodation units in the studied resorts correlate well with those recorded in our interviews with mayoralty officials from Predeal, Buşteni and Sinaia (August 2007). The local authorities admitted the existence of some winter climate phenomena with negative impact (e.g.

diminution of snow cover and even the impossibility of using artificial snow devices. The negative effects of global warming on mountain resorts are particularly warring as vast projects to extend ski tracks and artificial snow installations for the organization of the 2013 European Youth Olympic Festival, or the Small Winter Olympiade as it is called, are underway.

CONCLUSIONS

By and large, the development of winter tourism in the Prahova Valley – Poiana Braşov area, over a four-year period (2002-2006) did not fully correspond to characteristic winter temperature and precipitation conditions, according to decennial variability trends. However, at altitudes of ≥1,500 m winter tourism was less vulnerable to current climate trends, that is, to the general climate warming of the local mountain climate, because altitude is strongly influencing temperature and precipitation. So, high up, the snow cover did persist on the ski tracks of Sinaia and Poiana Braşov resorts. The general climate warming process in the studied mountain area tends to reduce even more the snow-cover interval, according to the records of the lower-altitude weather stations, due to marked thermal deviations. This reality is pointed out by meteorological observations after 1990 and moreover after 2000.

Since a clear-cut connection between weather variables and tourism indicators is missing, the answers given by tourism units managers from the study resorts are quite relevant. Their perception is that winter climate change has a negative bearing on their activity in certain tourist seasons. Thus, the presence of snow and the thickness of snow cover do influence the winter activity of most of these units and resorts, generally in various degrees. The physical factors involved are altitude of ski tracks, their exposure, presence of artificial snow installations, etc. In the conditions in which the structure and quality of accommodation facilities were improved and the motivation behind tourist demand is wide-ranging, the factors regulating the tourism market (profile of accommodation unit, e.g. comfort level, proximity to ski tracks) come into play, making the management staff plan out their policies for winter sports demand, or demand of other travel and tourism segments, in winter.

As present trends in temperature and precipitation conditions are supposed to continue, the mountain climate is expected to register moderate values, so that tourism activities relying on winter sports (skiing) will surely be affected. In this situation winter sports fans might choose high-altitude locations (e.g. Bâlea Cascade – Bâlea Lake ski tracks) for practicing their favourite sport, and/or opt for resorts abroad. This would put greater pressure on investors to adjust to the new climatic conditions (costly and sometimes futile investments) by acquiring artificial snow installations, or shift their business towards other segments of the tourist market.

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