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Winter Sports Resorts and Natural Environment—Systematic Literature Review Presenting Interactions between Them

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Abstract: The systematic literature review method was adopted to analyze the content of papers published since 2001 that focused on interactions between winter sports resort operations and the natural environment. A total of 86 papers published in journals indexed in SCOPUS data base were analyzed. Three main groups of topics presented in analyzed papers were found: the environmental impact of winter sports resorts, the management of environmental impacts and sustainable development of winter sports resorts, and finally the impact of climate change on winter sports resort operations. The biggest number of publications were devoted to the latter topic, and interest in conducting research within this area has apparently grown during the last two decades. However, most conclusions reached by the authors of numerous studies are site-specific and difficult to extend to other resorts/destinations. Additionally, the conclusions presented in many papers are contrary to the results achieved in other publications. Several gaps in our contemporary scientific knowledge and directions of future research are suggested in addition to the abovementioned results of the analysis conducted in the presented paper as the final conclusion of the research.

Keywords: winter sports; winter sports resorts; climate change; ecological impact; sustainable development

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1. Introduction

"Ski resort" is not a term defined in the literature, and usually it is used to name a locality where an infrastructure for skiers is located [1]. Some authors use this term to define a set of lifts and slopes under common management and accessed with a common ticket [2]. Less controversial are the terms "ski area" and "ski field," which are used almost only in the second stated possible meaning of "ski resort" [3,4]. The terms "ski resort," "ski area," and "ski field" are the traditional ones and have been commonly used for many decades, yet during this time several changes occurred. The most important one was the invention and growing popularity of snowboarding, usually using the same infrastructure that was prepared for alpine skiing. That was the reason why the terms underlying the word "ski" became insufficient, and "winter sports resort" or "winter sports destination" came into use. Contemporarily both terms "ski resort" and "winter sports resort" are used commonly to label the same entity. To keep the consistency of the text in the presented paper the term "winter sports resorts" is being used solely and is understood to be a tourist destination of a special kind, identified by the unique tourism infrastructure and how visitors spend their time there [4]. If it is agreed that a tourist destination is a place with physical, historical, and ethnographic features that differentiate it from others in such a way that it can attract non-residents and develop one or more different kinds of tourism [5], the winter sports resort or destination may be defined as a geographical, economic, and social unit consisting of all those firms, organizations, activities, areas, and installations that are intended to serve the specific needs of winter sports tourists [6]. This approach emphasizes the complex character of a ski resort with a clear indication of the role of supplementary services (hotels, gastronomy, entertainment) and environment. However, the presented

terms might be used with a different meaning in the papers analyzed here. It is clear that infrastructure in winter sports resorts nowadays embraces much more than ski lifts and slopes and can be connected also with other winter activities, including cross-country skiing, ski touring, sledges, toboggans, and ice skating [7]. However, this does not change the fact that in most of the cases lifts and slopes are the main reason to visit a resort [4]. Additionally, the problems presented in this paper concerning the relationship of winter sports resorts with the natural environment are visible mainly in the cases of alpine skiing and snowboarding infrastructure [8]. That is also the reason why most of the analyzed texts are focused on alpine skiing and snowboarding when we analyze "ski resorts" or "winter sports resorts."

Winter sports resorts are a special type of tourist destination due to, among other things, the complex and two-way nature of their relationship with the natural environment. These resorts' success depends on the specific features of the environment, the lay of the land, climate, and transport accessibility [7]. On the other hand, winter sports resorts are also often perceived as places where particular threats to nature occur [8]. This is due to the large-scale nature of investments that interfere with nature, the accumulation of a large number of tourists, and also the fact that they are usually established in mountain areas characterized by the highest value and sensitivity of ecosystems. All this is the reason why the interaction between the natural environment and winter sports resorts is the subject of multiple scientific studies conducted by representatives of various scientific disciplines. These studies have also been conducted for many years [7,9–12], but it should be noted that the subject of interest in this research has evolved over the years due to the increasing scope of scientific knowledge and due to new challenges that have arisen. Today, undoubtedly, an example of a challenge like this is global warming, which calls into question the presence of natural snow cover in many places where winter sports are traditionally played [13]. The relationship between winter sports resorts and the natural environment, and, in particular, the scale of the negative impact of the development of winter sports on the surrounding nature, are also the subjects of multiple and often very highly charged emotional debates of a political nature, dominated by catchy arguments based on far-reaching simplifications, used both by representatives of ecological and environmental organizations and by promoters of winter sports development.

Despite the significant increase in scientific research on the impact of winter sports resorts on the environment or on how the environment influences the way these resorts operate, the common scientific knowledge on this subject is highly fragmented. In many cases, highly specific issues are the subject of research—for example, the impact of the development of a winter sports resort on particular species of amphibians or grasses, which, in addition, are site-specific, while works that show in a more comprehensive way the relationship between nature and how the winter sports resorts operate are missing [14,15].

The research carried out according to the systematic approach to literature review methodology is an attempt to collect and structure the contemporary scientific achievements on the subjects of the relations between winter sports and the environment and of the sustainable development of winter sports resorts. The research took into account publications that were published during 2000–2020 in journals indexed in the SCOPUS database. This time span allowed not only to indicate the most interesting areas of scientific research, but also to observe how they have changed over the last 20 years.

2. Materials and Methods

Like many other review papers [16,17], this paper takes a systematic approach [16,18,19] to the literature review. A systematic review is a specific method that locates existing studies, selects and evaluates contributions, analyzes and synthesizes data and reports the evidence in such a way that it allows to reach reasonably clear conclusions about what is known and what is not [20].

The synthesis of the findings is the key point of all systematic reviews [21–23]. There are many methods to approach a systematic review. As the data for this review (the papers

collected) contain a combination of quantitative and qualitative research, pure quantitative analysis of the data is not appropriate. The aim of this review is not to assess all literature written on the sustainable development of winter sports resorts or on the interactions between winter sports and the natural environment, but rather to capture the current state of our scientific knowledge in the specific area.

The review seeks to create a comprehensive database of all tourism and hospitality journal articles published between January 2000 and April 2020 covering the issue of a relationship between the natural environment and the management of winter sports resorts. There are a number of different approaches to selecting databases to search for suitable publications, which let you use a different number and different kinds of databases, starting from scientific search engines (google.scholar.com) [24,25], through indexing bases (SCOPUS, Web of Science) [24–30], ending with full-text sources of references (e.g., EBSCOHost, Science Direct) [24,31]. It was decided to use the SCOPUS data set as a source. It is one of the most appreciated and complete indexing reference databases, which is a guarantee of the scientific quality of publications presented there. SCOPUS has been widely used so far as a sole data set for literature reviews [26,32–34]. According to Meho and Rogers [35] this data set is especially useful for literature reviews in the fields of life sciences and social sciences, which are the most important scientific disciplines dealing with the issues analyzed in the paper. However, SCOPUS does not provide full-text versions of indexed papers [26,28,29]. This choice required subsequently finding full-text versions of the selected papers in other sources.

Since the researched topic contained a set of different relations, a complicated search strategy was adopted. The key words: (ski OR "winter sports") AND (sustainability OR climate OR environment OR green OR ecological) AND (management OR business) were used to search titles, keywords, and abstracts of publications. Additionally, the search was limited to scientific papers only and to finished publications. Additionally, to exclude papers that were not related to the area of the research, the results were limited to papers in environmental, social, and business sciences. Finally, the time span, i.e., 2001–2020, was set. The presented search strategy allowed to detect a group of 168 publications. The next step was to read carefully the abstracts of all selected papers and to reduce the list by skipping the papers that did not fit the topic. The final list of accepted papers was 86 items [36–121]. The reasons why some papers were skipped were diverse. Most frequently, these were the papers that presented a general idea of tourism development in a particular area and winter sports resorts were just one field of such a development, and an in-depth study was not made. Another group of papers we skipped contained articles dealing with cable cars or lifts but with those that were used for purposes other than winter sports. Finally, there were several articles that presented the general problems of nature conservation in a particular area, and winter sports were analyzed only as part of the environmental impact on nature and, again, an in-depth study was not made. As the last step, an in-depth study was made of all papers contained in the final list to analyze their methods and conclusion.

3. Results

3.1. Topic Covered

All selected papers were divided into three categories (however, one paper could have been put into two categories at the same time) regarding the topics analyzed in the article. Those topical categories were as follows: environmental impact of the construction and operation of winter sports resorts ("environmental impact"), management of the sustainable development of resorts ("management"), and impact of climate change on the operation of resorts ("climate change"). Finally, four papers were focused on other topics and were put into the fourth category that was labeled as "others."

From among 86 scientific articles analyzed, as many as 51 were devoted to the issue of climate change, 30 were included in the "management" category, and 23 were included in the "environmental impact" category (Table 1). Moreover, four articles dealt with other issues, not related to any of the three subject groups mentioned above. They were: the

influence of the weather on the sale of ski-tickets; the impact of ecological uncertainty on the management of resorts; stakeholder cooperation in the ski region versus ecotourism region; and the perception of avalanche danger by skiers.

Table 1. Number of Papers Published Year by Year.

	Climate Change	Environmental Impact	Management	Others	Total
2020	3	0	0	0	3
2019	12	2	5	0	19
2018	3	1	2	1	7
2017	2	0	1	1	4
2016	4	3	2	1	10
2015	5	0	0	0	5
2014	6	1	2	0	9
2013	6	2	4	0	12
2012	0	6	4	0	10
2011	3	2	3	0	8
2010	1	1	0	0	2
2009	0	3	2	1	6
2008	2	0	1	0	3
2007	1	0	1	0	2
2006	2	0	1	0	3
2005	0	1	0	0	1
2004	0	0	1	0	1
2003	1	1	1	0	3
2002	0	0	0	0	0
2001	0	0	0	0	0
Total	51	23	30	4	108

The number of publications that dealt with the relations between the operation of winter sports resorts and the natural environment in the last two decades was highly variable, but it was clear that many more of them were created in the second decade than in the first decade of the century. During the first years of this decade (2011–2012), the number of publications on the "environmental impact" and "management" largely increased, while during the following years, the "climate change" subject became much more popular. As many as 42 out of 51 publications identified as addressing the "climate change" subject were created in the years 2013–2020. This was as much as 69% of publications published in those years. The authors' growing interest in the "climate change" subject was also evidenced by the average age of the publications analyzed. Publications on this subject were, on average, 5.1 years old, while the average age of articles on the "environmental impact" was 7.7 years, and on "management" was 7.3 years. The increasing number of publications on climate change over the last decade should not be a surprise. This topic was not particularly popular in the public debate even at the end of the 20th century, not only in the debate on winter sports, while the second decade of the 21st century was a time of rapidly growing social awareness of the consequences of climate change. It was also the time when the problem of maintaining snow cover in the winter season more and more severely affected an increasing number of resorts.

Big and growing interest in the "climate change" subject was also reflected in the number of citations of the articles analyzed. Despite the fact that, on average, articles on "climate change" were more than two years younger than the other articles, they were cited most often—the average number of citations was 32, while in the case of "environmental impact" and "management," it was 16 and 31, respectively. A clear difference between the number of citations of these two topics was also highly conspicuous, and the average number of citations for "environmental impact" was two times lower than for those for "management." Seven publications among the analyzed ones were cited over 100 times, and the most frequently cited item was cited over 200 times (Table 2). From among the most frequently cited publications in Table 2, as many as four, and these are the four with

clearly the highest citation index, were works on the "climate change" subject. Moreover, all four articles were linked by the co-author, i.e., D. Scott. It is also worth noting that the publications listed in Table 2 clearly dominated over the others in terms of the number of citations. Only several works had more than 80 citations. It is also worth remembering that the average number of citations index in the case of publications issued over many years covers very large discrepancies between individual articles. Publications published in recent years have been cited very rarely so far; some of them have not yet been cited at all, which is natural. All the articles contained in Table 2 were published in the first decade of the century; items with only slightly fewer citations also came from the same period of time. In this context, it is worth paying attention to two articles that clearly broke out of this pattern. The first of them was Steiger et al. (2019) [43], which managed to be cited 44 times over the year, while all other publications from 2018–2020 were cited only 34 times in total. The second one of them was the article by J. Dawson and D. Scott, (2013) [87], which was the only one published after 2009 to have received more than 70 citations (86). It is worth noting that both of these items were on "climate change" (the article by Dawson and Scott (2013) was also on "management").

Table 2. The Most Commonly Cited Articles.

Authors	Topic	Number of Citations
Scott, D., McBoyle, G., Mills, B. [120]	Climate change	219
Scott, D., McBoyle, G [114]	Climate change	173
Scott, D., McBoyle, G., Minogue, A., Mills, B. [116]	Climate change	152
Scott, D., Dawson, J., Jones, B. [111]	Climate change	135
Rivera, J., de Leon, P. [119]	Management	123
Sharma, S., Aragón-Correa, J.A., Rueda-Manzanares, A. [113]	Management	112
Wipf, S., Rixen, C., Fischer, M., Schmid, B., Stoeckli, V. [118]	Environmental impact	108

3.2. People and Places

The issue of the relationship between the operation of winter sports resorts and the natural environment was taken up by researchers from almost all continents. Most often these were scientists affiliated with the USA (18 articles), Austria (16 articles), and Canada (11 articles). In addition, researchers affiliated with France, Spain, Italy, Germany, Switzerland, and Australia were also authors or co-authors of more than five articles. Among the scientists, there were also representatives of countries like Andorra, Serbia, Bulgaria, Finland, Japan, Iran, and Malaysia. By far, D. Scott, who was the co-author of all 11 publications affiliated with scientists from Canada, was the most active author. In addition, R. Steiger was co-author of seven publications while M. Pons was a co-author of five articles. It should be noted that all three authors often published articles jointly and all their presentations were focused on "climate change." It is also worth noting that D. Scott was one of the precursors of research on the impact of climate change on winter sports resorts, and his publications were written during the entire period that was being analyzed—the oldest was written in 2003, the newest in 2020.

The analyzed articles were published in multiple journals of various profiles. This was very clearly shown by the fact that the most articles published in the same journal was eight. This applied to *Tourism Management* and to the *Journal of Sustainable Tourism*. Nevertheless, the next journals in this ranking were *Environmental Management* and *Journal of Outdoor Recreation and Tourism*, from which only four articles were taken. Most articles were published in journals dealing with the subject of tourism (apart from those mentioned, they were, among others, *Current Issues in Tourism* and *Tourism Review*), but they were

also published in journals devoted to issues of, broadly understood, ecology (apart from the aforementioned, these were also, among others, *WIT Transactions on Ecology and the Environment* and *Sustainability*), regional problems (*Policy Studies Journal*, *Revue de Geographie Alpine*), or, narrowly understood, climate issues (*Climate Change* and *Climate Research*).

The affiliations of the authors of the publications analyzed were reflected in the spatial scope of the research conducted. As many as 22 articles were devoted to the analysis of resorts located in the USA, moreover, 13 were located in Austria and eight in Canada. Some publications did not undertake research located in specific countries; in several other papers, the spatial scope covered multiple countries, in particular, those located in the same mountain range, e.g., the Alpine or Pyrenean countries. There were also cases of publications that made comparisons between countries or even continents.

3.3. Methods Used

Taking into account that the authors of the publications analyzed were researchers who represented various scientific disciplines, it was also obvious that in their research they used multiple and different research methods typical for a given discipline. Surveying methods were often used in the research, which are part of the broadly understood stream of social sciences. In 16 publications, surveys conducted among consumers or stakeholders in winter sports resorts were used, while in another six works, the method of in-depth interview was used. For representatives of natural sciences, it was more typical to collect and use the data on natural phenomena that were already available in a specific place (total of 24 publications). The development scenario analysis was used in 12 publications. Moreover, in 10 articles modeling methods and in eight regression methods or econometric models were used. Quite often, the considerations of individual authors were focused on conducting a comparative analysis (10 publications) or using the case study method (6 publications). In three articles, literature studies were the leading method of analysis.

3.4. Environmental Impact

The vast majority of works that dealt with the impact of winter sports resorts on the natural environment used approaches and methodologies typical of natural sciences. Most often, research was conducted to identify the impact of the operation of a winter sports resort, or a single aspect of it, on a specific element of the environment. Both the impact of building resorts as well as new ski runs [63,108], and the impact of the resort's operation on an ongoing basis [62,103] were considered separately. In the latter case, all works were dominated by papers that analyzed the maintenance of ski runs, i.e., snowmaking [42,97,100,107,118] and grooming [100,105,118]. It is worth noting that in most of the works, these two aspects of the resort's operation, i.e., snowmaking and grooming of ski runs, were indicated as the most harmful from the point of view of the natural environment. Also on the part of the natural environment, a specific fragment was analyzed more often than an aggregate. The elements of the natural environment analyzed in multiple studies were soils [44,100,103] and grassland [44,103] or, to put it more broadly, vegetation [94,96,100,118]. The influence of the resorts on the animal world was the subject of the analysis relatively less frequently. The article by Sato et al. [79] was an example that presented the threat posed by winter sports resorts to reptiles, and works by Brambilla et al. [63] and Caprio et al. [64] analyzed threats to birds. The attention was drawn to, among others, the need for intensive measures to revegetate ski runs. Although these actions would not restore bird species diversity to the state it was before the construction of ski runs, they would significantly improve this diversity [64]. However, Burt [94] indicated the right mixture of flora species that would allow to effectively revegetate ski runs. Still, restoration of grasslands on ski runs caused a recovery in the bird community, but not to the extent equivalent to a natural Alpine grassland community [64]. On the other hand, in the article by Kangas et al. [108] analyses of the impact of the operation of winter sports resorts on water quality were made, and it was indicated that the state of waters polluted by the resorts is similar to those polluted by agriculture and forestry; whereas

Vanham et al. [107] indicated how important for local water conditions is the demand for special reservoirs needed for snowmaking as a result of large seasonal water fluctuations. Completely different conclusions were also obtained in the work by Barrantes et al. [85]. In their research, these authors compared agricultural land and land used for ski runs and noticed that once the land used for grazing was converted to ski runs, its biodiversity increased. Due to the dominant methodology of analyzing data related to a specific place, a significant part of the results and conclusions could not be merely transposed in a simple way into analysis and management of resorts located in different natural conditions. On the other hand, it was noteworthy that the vast majority of studies showed a very strong and negative impact of the construction and operation of winter sports resorts on individual elements of the environment.

The work by Kuščer and Dwyer [41], where the scale of environmental impacts of various winter sports resorts was compared and where the ability to generate a smaller environmental impact per visitor in the case of large winter sports resorts than in the case of small resorts was indicated, was an example of a publication in which a slightly different perspective was adopted from those described above.

3.5. Climate Change

Climate change remains among the most important factors impacting operations of winter sports resorts worldwide as it influences snow conditions. According to Spandre et al. [61] the snow conditions are a major priority for ski resort operators to provide comfortable skiing conditions, to ski back down to the village, or even to connect with neighboring resorts. Multiple studies by climatologists that show the dramatic momentum of climate change and its potential consequences have now made climate warming one of the most important topics undertaken by policy makers, entrepreneurs, and scientists. One of the first observations related to the climate change was the observation that winter sports resorts can now operate on much smaller scales [116,120]. For many years, they have been indicated as one of the most typical examples of human economic activity that would be impaired as a result of these changes [84,87].

Works on the issue of the impact of climate change on the operation of winter sports resorts most often adopted one of the two research perspectives. The first of them, the more analytical one, predicted the impact of climate change on winter sports resorts in a selected area, depending on how these changes took place [36,37,51,87,116]. In this approach, detailed data contained in the climate change scenarios were used. With this approach, the scale of the impact of climate warming could be indicated at various points in time and dependent on how this change developed. This research was conducted in multiple regions of the world, starting from the USA and Canada [36,40,87,116], through the Alpine countries [37,46,112] and the Pyrenees [71,82], ending with Japan [55] and India [77]. It is worth noting that in different parts of the world, i.e., in different resorts, conclusions of the analyses were different from resort to resort. In some cases, even in the optimistic carbon dioxide emission scenario, the normal operation of the resorts was in danger as early as in the fourth decade of the century [46,51,77], while in other studies, even if the scenario was pessimistic, the resorts' operation could have only been restrained in the long term (second half of the century) [84,111]. In this context, the anticipated shortening of the season and the decrease in carnet sale revenues, e.g., in Slovak resorts, according to the study by Demiroglu et al. [72], should be treated in terms of an optimistic scenario. However, most studies showed a large difference in the prospects for the operation of winter sports resorts, depending on the carbon dioxide emission scenario that took place there [36,37,83,116]. Discrepancies between individual studies could also be seen in terms of how the climate warming affected the weather conditions in each place. The research by Dar et al. [77] indicated a very significant warming in the winter season and, as a result, a reduction of snow cover in Kashmir, while Fischer [74] indicated that in the case of Austrian Tirol, climate warming mainly applies to the summer season, and there are only slight temperature fluctuations in winter. Taking into account these quite significant differences

in the impact of climate warming on various resorts, in several research studies [71,82] attempts were made to group the resorts according to how seriously they were exposed to climate change. The most common factor that differentiated this impact on resorts located in one region was, quite obviously, the height above sea level.

The second thread of considerations taken up most often in publications on "climate change" was how the boards and stakeholders in winter sports resorts reacted [38,76,79,104]. It was not a surprise that the two main strategies considered in response were: extended use of artificial snowmaking of ski runs [55,76] and the resort's "escape" to greater heights [82,99]. The implementation of each of these two strategies involved a significant increase in the operating costs of the resort. Moreover, for many resorts that already operated at the highest available heights, expansion to higher altitudes was impossible [82]. Therefore, how the global warming threat could be limited with the expansion of artificial snowmaking on ski runs was a matter of particular concern [55,61,83,86,120]. The results obtained in individual studies were quite significantly different. In some studies, the importance of artificial snowmaking was indicated as an effective response to climate warming. This allowed to make the risk as small as possible [116,120], or even to make it the only option to survive for resorts [55,111], while, in other resorts, a minor significance of this solution was indicated, as the one of minimum risk of no snow cover and that generates significant costs [83]. These discrepancies are mainly the result of two facts. The first and the obvious one is again the issue of conditions that are unique in the various regions of the world studied. The second, however, is the issue of an approach to artificial snowmaking itself and the technological progress that has already been made and will probably still be made in terms of the efficiency of technical infrastructure. In some studies, it was assumed that the temperature range slightly above 0 °C prevented the operation of snowmaking devices. However, devices are now available that make it possible to produce artificial snow at almost any temperature, but the problem is then undoubtedly the costs of purchasing and operating such devices, as this makes the resort's operation unreasonable in terms of finance [73,83,104,120]. It is exactly what the efforts of researchers in this topic should be focused on in the near future, i.e., cost restrictions of artificial snow, its ecological consequences, as well as the problem of access to water and energy resources needed for snow production [89]. Spandre et al. [61] underlined that the access to the water volumes needed to produce machine-made snow is already unequal between resorts, most of them relying on water reservoirs, and any evolution of the need for additional snowmaking will require a proportionally higher water supply, storage, and related costs. An interesting area of scientific considerations and actions taken by decision makers in winter sports resorts were in this context also indicated by Weiss et al. [39]. They indicated the efficiency of snow storage as an effective strategy to reduce the scale of current production.

Occasionally, in the research on "climate change," other threads were also included. Most often, they were devoted to research in the perception and behavior related to climate warming among various stakeholders of winter sports resorts, on both the demand and supply sides. In some works [47,48,76,115] the attitudes of people managing and/or participating in the development of winter resorts toward climate change were analyzed. They confirmed that the respondents were quite aware of these changes, but this awareness was not fully translated into specific long-term actions [69]. Resort managers adjusted to the annual fluctuations in the weather, rather than to a long-term change [69]. As a result, actions were often taken as a reaction to the changes that took place and were already seen, rather than those anticipated, and decision makers in resorts that were less exposed to climate warming threat were less inclined to implement adaptation measures [40]. There was widespread belief that artificial snowmaking on ski runs is effective [69]; in some cases, the need to diversify the resort's activities and to increase the off-season revenues was also emphasized [78,89]. In the research by Trawöger, [75], four groups of stakeholders in Tyrolean winter sports resorts were distinguished based on their attitude toward climate change. These groups were characterized as: convinced planners, annoyed deniers, ambivalent optimists, convinced wait-and-seers. The insufficient number of actions taken by

decision makers in winter sports resorts were not only a result of their passive attitude, but also of insufficient resources of knowledge available to them, including research and scientific publications [114]. In managing winter sports resorts, weather variables were used far too seldom. They currently reflected the ongoing climate changes [102]. Another interesting conclusion was reached by Hoffman et al. [109] who found a positive influence of the awareness of possible climate change effects on the scope of corporate adaptation, but no significant influence of the vulnerability to climate change effects on the scope of adaptation could be found in their research.

Other interesting conclusions were drawn on the basis of the research on skiers and the analysis of their attitudes and behavior toward global warming [70,90]. As in the case of the supply-side research, in this case it was also found that relatively high awareness of changes was not associated with a significant modification of behavior [49,50]. Skiers who received information about problems with maintaining snow cover in a particular winter sports resort may make different choices depending on the market segment they represent. Generally, people who are more focused on skiing or snowboarding, are more likely in such a situation to choose another resort, while people who pay more attention to the experience of just staying in a specific place are more loyal to resorts more affected by climate warming [68,70]. Eventually, Gonseth [86] found that ski areas benefiting from sunny conditions tended to have more skier visits, which might suggest that additional impacts such as climate change may modify sunshine duration in mountain regions.

3.6. Management

The publications analyzed on this issue in large extent referred to management strategies and tools appropriate when faced with the situations presented like: "environmental impact" and "climate change." Decisions on which directions and what methods will be developed by the resorts, which are taken at the level of the management boards of individual resorts, were often criticized for disregarding the principles of nature protection, including fundamental ones like the protection of plant and animal species under legal species protection [63,70]. According to Luthe et al. [91] it is necessary to take a comprehensive view of how the tools and activities are designed in winter sports resorts to assess their impact on nature and make it as little as possible. On the other hand, Krtička et al. [53] called for allocating the profits from the operation of individual resorts to nature protection instead of further development of infrastructure.

A typical issue for this section of subjects was whether it made sense for individual winter sports resorts to participate in various types of voluntary programs for implementing sustainable development and eco-labeling and, if so, how to be motivated to do it [58]. According to Rivera and de Leon [119], resorts' participation in these programs is motivated only by opportunistic reasons and may be forced by external pressure. Their findings indicated that participation in one of these programs by ski areas is a result of institutional pressures in the form of enhanced federal oversight and of higher state environmental demands exerted by state agencies, local environmental groups, and public opinion. George [121] was critical about one of the most popular programs of this type in the USA, i.e., sustainable slopes charter. On the basis of the survey research he conducted, he claimed that the program is perceived as a fig leaf, and its only positive effect is an increase in environmental awareness among the resort's guests. How important the participation of winter sports resorts in voluntary environmental programs (VEPs) is as a management strategy and response to this external pressure from customers was also questioned in the research by Needham and Little [88]. The results of their research suggested that the majority of visitors to the resorts not only knew nothing about these programs, but they were not motivated by them in any way in making their decision about which resort to choose. On the other hand, research by Needham and Little [88] allowed to indicate the characteristics of the features of visitors who were motivated by these programs. Respondents who were motivated to visit Mt. Bachelor ski area in Oregon, USA, because of the voluntary environmental programs were more attached to this area

and biocentric or environmentally oriented. Critical comments about VEPs, in particular, those related to being unaware that they exist by all involved, were also expressed by Little and Needham [98] as well as Rivera et al. [117] in their articles. The involvement of winter sports resorts in eco-labeling programs was also critically assessed [58]. According to Sato et al. [58] so far they have not met the expectations of the resort's customers and are focused too much on by-products, while skiers expected the skiing environmental effects rather than general ones. On the other hand, Duglio and Beltramo [66] were less critical about eco-labeling winter sports resorts. They pointed out that eco-labeling can be used at both the winter sports resort and destination levels. However, its effectiveness and impact on the profits of individual resorts varies from resort to resort [65], while the use of eco-certificates improves some companies' results, at the same time it lowers other companies' results. In the context of the above critical remarks, the title question from the paper by Rivera et al. [117] "Is greener whiter yet?" does not seem to have a positive answer. On the other hand, it should be kept in mind that the main subject of research in the works cited was primarily the marketing effectiveness of the environmental practices used, while there is no detailed research on what extent the implementation of sustainable slopes charter and other VEPs have influenced the actual level of impact exercised by individual resorts on the state of the natural environment. Nevertheless, in the only article analyzed [117] that raised these issues, it was indicated that no evidence was found to conclude that ski areas that adopted the VEPs displayed performance levels that were superior to nonparticipants for the following areas of environmental protection: overall environmental performance, expansion management, pollution management, and wildlife and habitat management. VEP participants only appeared to show a statistically significant correlation with higher natural resource conservation performance rates. Not only is individual resort participation in VEPs of particular importance, but also the proper communication of environmental policy, which will help to create the desired marketing effects of this kind of resort involvement [92]. Spector et al. [92] indicated that the resorts belong to one of four groups in how they conduct and communicate their ecological policy: passive, exploiting, reactive, and proactive. Additionally, the need to examine the motivations behind ski resort publications on environmental communications and the likelihood of skiers selecting resorts based on the environmental communications posted on websites was underlined [92].

The negative impact of winter sports resorts on the natural environment was the source of multiple conflicts: those understood literally, i.e., conflicts of resorts' managers with nature protection organizations and institutions, and conflicts of values. The source of these conflicts could be both the operation of resorts as a whole and their individual actions. In addition, these conflicts were aggravated by the negative impact of climate warming, which made the resorts' managers operate under greater economic pressure, while nature presented an additional negative factor. The issue of managing these conflicts was often discussed in publications in the field of "management" [106]. The issue of access to the water resources necessary to intensify artificial snowing and how it is consumed [89] was an example of the conflict between nature and the operation of winter sports resorts that has become more and more serious in the conditions of global warming. According to Morrison and Pickering [89], this conflict can be solved only by cooperation of multiple stakeholders involved in this problem. On the other hand, Sharma et al. [113] indicated how important organizational capabilities are in managing conflicts related to nature conservation in the surroundings of winter sports resorts. There was no doubt that the use of ecological innovations in managing winter sports resorts [101] was an important strategy to mitigate conflicts related to nature protection. Smerecnik and Andersen [101] warned against, as it seems, simple diffusion of these innovations, which is not correct. Another conflict was analyzed by Bausch et al. [42]. They indicated that while fighting the effects of global warming extensively using artificial snowmaking, winter sports resorts do not meet the expectations of recipients. What is more, they do not meet these expectations for two different reasons. Firstly, it increases the operating costs of the resorts, and, as a

result, it increases the prices of tickets, and secondly, it causes the resorts to be perceived as anti-ecological, which in turn has a negative impact on guests' loyalty. On the other hand, Dornier and Mauri [54] indicated that regardless of what kind of the problems there are here, winter sports resorts will have to change the way they operate so that their operation is subject to the principles of sustainable development to the greatest extent possible.

4. Discussion and Conclusions

Although the number of publications concerning the relationship between the operation of winter sports resorts and the natural environment has significantly increased, it seems that the level of contemporary scientific knowledge about the phenomena in research is highly insufficient. One of the main issues noted in the conducted analysis of the publications, which allows to put forward a far-reaching thesis, is the significant inconsistency of conclusions resulting from individual studies. The obvious facts about the negative impact of climate warming on the operation of winter sports resorts and the negative impact of these resorts on the natural environment are undeniable conclusions that are not put into question in any way in any of the texts. However, the scale of these influences and ways to limit them remain a controversial issue. In most publications [42,46,61,97,100,104,107,118], the issue of artificial snowmaking was important. On the one hand, it was presented as the only or the most effective panacea for the effects of global warming [55,61,83,116,120], and, on the other, as an element particularly responsible for environmental degradation [42,97,100,107,118]. The significant number of publications on snowmaking of ski runs and the relative consistency of the conclusions drawn from these publications encourage further research on this issue, both in the context of climate change and in the context of nature degradation. Economic and environmental analysis of other possible climate change response strategies, such as "escape" to higher altitudes [82,99], is also an urgent issue. In the sources analyzed, there were no clear suggestions as to whether this could be an alternative to continue intensifying snowmaking of ski runs with sufficient efficiency, whether this alternative is financially attractive and, finally, whether it is less harmful to nature. Other, more "traditional" elements of the impact of winter sports resorts on nature, such as noise, deforestation, generation of garbage and sewage, etc., also require further analysis. Despite the fact that these elements were recognized as contributing to the significant negative impact of winter sports resorts on nature many years ago [1,3,8,9,122,123], in the last two decades these topics were practically not discussed at all, and it is hard to suppose that the knowledge available from publications from the twentieth century is fully up-to-date in the present conditions. The sustainable development perspective on winter sports resorts requires also more attention to the needs of local inhabitants, which seems to be in times of overtourism identified also in nature-based destinations [124,125] as a crucial direction of future research.

There was a relative consensus among the authors of individual publications [88,119,121] about whether the tools used today as a response of the winter sports resorts management to climate warming and to the growing awareness that it is necessary to limit the negative impact of these resorts on nature are sufficiently effective. However, the question remains unanswered whether voluntary environmental programs or eco-labeling programs are insufficient tools and whether it is necessary to search for more effective tools, or whether it is enough just to refine the way they are applied.

Relatively few publications [58,66,90] presented the role of consumers in the analysis of the winter sports resort–natural environment relationship. On the one hand, their mere presence, as well as specific behaviors, are part of the negative impact of a winter sports resort on the environment; on the other hand, it is often the choices they make as to the destination of their ski trips and about a ski trip in general that are the primary targets of all actions made by winter sports resort managements designed to make both the ecological impact of the resort and the impact of climate warming on this resort as little as possible [58,65]. Whereas the results of the few analyzed studies [88,98,117] that referred to

the role of the consumer in the topic discussed indicated, above all, that there is no effective communication about the actions taken and, as a result, customers are not aware of it.

There is no doubt that the attention of researchers today is more and more focused on the analysis of the current and future consequences of climate warming. This was clearly evidenced not only by the number of works on "climate change," but also by how rapidly the number of these works has grown in recent years and the huge number of citations of most of these works. Scientific knowledge about climate change issues and their impact on the operation of winter sports resorts has undoubtedly been significantly developed in the last two decades, however, also in this case many gaps can still be seen. This is a challenge and a field for future, further research. At the moment, the most important of them seems to be the limitation of research and conclusions in most publications [36,37,40,46,55,71,87,112,116] to resorts located only in a specific smaller or larger region, with highly reduced possibilities of extending these results to other locations. There are no reviews that synthesize conclusions obtained in different regions, which would allow to identify key factors that affect the scale of threats in individual resorts. A set of factors like these would be relatively easily used in the analysis of future opportunities and threats for resorts for which a research like this has not so far been conducted.

To sum up, it can be concluded that the conducted analysis allowed to identify a surprisingly large number of gaps in contemporary scientific knowledge on the issues that have been the subject of research for many years. On the other hand, it is also true that the research area contains issues that are rapidly evolving in the contemporary world and issues that were previously not taken into account, such as the impact of global climate change. All this generates new challenges for the managers of winter sports resorts and, as a result, new fields of research and scientific analysis that still need to be filled with further research.

The scientific output of the presented paper is connected mainly with the detection of several gaps in contemporary knowledge and pointing out numerous directions of future research. All three topics identified in the literature review require urgent development. In the case of "climate change" and "environmental impact," future research should be focused on the search for general, global rules, as most contemporary publications give insight only into the local/regional conditions of particular resorts. In the case of "management," the most important direction of future research is an understanding of the reasons for the low effectiveness of VEPs and the establishment of new, more effective tools. Additionally, the ways of effectively using artificial snowmaking and making it less dangerous for the natural environment is another issue that requires extensive research in the future. Those implications related to the topic "management" might be perceived also as the most important managerial implications of the paper; however, in a paper dealing with a literature review the most important expected output is always theory development, and practical recommendations play only a supplementary role.

The limitations of the presented conclusions are partly a result of the specific method itself. Firstly, selecting the SCOPUS database as the basis for the search may seem controversial, just like any other alternative choice, and publications can be indicated that were published in the period analyzed and were involved in the issues analyzed, but were not included in the list because they were published in journals that were not indexed in SCOPUS. Nevertheless, the SCOPUS database is considered to be one of the most prestigious and one that contains the most influential scientific journals [25,28,29]. Hence, it can be assumed that publications that are not in journals contained in this database have a smaller impact on the development of the contemporary scientific knowledge [28]. Selection of the proper data set/data sets always remains the controversial part of any literature review, regardless of the choices made. This selection is always a compromise between the creation of a manageable set of papers and the inclusion of all papers having a significant scientific impact on future research [24]. The creation of a too wide set of papers might also be controversial as too much attention can be put on the papers having very little impact and too little attention on the most important ones. Among reasonable alternatives for using

SCOPUS, the Web of Science (WoS) database can be stated [29]. Contemporary literature offers arguments supporting the use of both of these databases solely and commonly, and none of them remains without questions.

Objections may also be raised to the scope and details of the search formula used, which allowed to select a manageable collection of publications. However, it cannot be ruled out that in the SCOPUS database there are also individual subsequent publications on the issues discussed that were not included in the selected list. Nevertheless, it seems that in this case it is not the issue of the detailed elements of its application that is the most important limitation of the method, but the problem is how to keep up with the rapidly developing scientific knowledge. In the list, articles published over the course of almost 20 years were analyzed. Equal attention has been paid to both older and newer publications. Whereas, what was known about causes, effects, and expected scenarios of global warming quickly evolved during that time. The natural conditions associated with the effects of this warming that could have been seen more and more clearly have also changed. Therefore, there is a risk that some of the results and conclusions drawn from the older publications may turn out to be at least partially out-of-date in the contemporary world. It may also be one of the reasons why the research results presented in various publications indicated in the text were different. It was necessary to close the list at a specific point in time, therefore, it was another limitation to the results of the analyses conducted. Certainly, between that moment and the moment this article is published, more articles on this subject matter will have been published. The numbers that show the level of citation of individual publications will have certainly changed, as well.

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