

Data and Elaboration on the Italian Alpine and Pre-Alpine Ski Stations, Ski Facilities and Artificial Snowmaking

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1. Introduction

The present analysis is intended to show the possible impacts of climate change on Italian winter tourism, in particular in the Italian Alps, whose territorial sustainable management is covered by the Alpine Convention. The attractiveness of the Alps and other mountain areas in Italy as tourist sites is confirmed by the actual trend concerning mountain tourism. According to a recent analysis (ISTAT, 2006) this trend shows an increase of 2,4% in the 2004/2005 period .

Italian Alps cover more than 27% of the territory under the scope of application of the Alpine Convention². Since the first half of the 20th century winter tourism has developed and has become a main contributor to this territory's wealth. In this area winter tourism relies upon its ecosystem services but, nevertheless, environmental costs deriving from winter tourism activities are not always included in researches on socio-economic aspects of tourism.

In Italy, a main destination for winter tourism is presently represented by the Alpine arc which covers almost 17,4% of the national territory from North-West to North-East and includes seven regions.³ Climate change impacts on snow cover, global warming and variations in season length are key factors to assess the possible impacts of environmental degradation on mountain tourism in Italy.

The risk of economic losses in winter tourism due to warmer winters and less snow cover, especially at lower altitudes (less than 1500 m) has been identified as a key vulnerability for the Alpine region (EEA, 2005).

With regard to data collection, even if the analysis tries to gather some basic data concerning the whole Italian alpine area in order to supply more detailed information when available through some regional case it has been recognized that one of the major problems is the difficulty to collect Italian integrated data at national level.

Furthermore, in Europe, a certain lack of harmonization regarding the terminology used for defining ski areas and ski resorts impede to give a set of entirely comparable data. In order to give a reliable picture of the Italian situation, the analysis has considered the available data concerning single ski resorts, without taking into account larger aggregations, such as ski areas.

For example, the collection of officially validated data concerning artificial snowmaking on the installed facilities is rather difficult: comprehensive statistical datasets for the Italian alpine regions are lacking and errors in over- and/or underestimation of these data exist.

In the framework of an analysis on the effects of climate change, it is essential to take into account some structural differences among ski centres. In fact, different response strategies can be adopted depending on the expected economic value of winter tourism in a certain area. For example, the hypothesis to move ski facilities at a higher altitude can not be economically viable (neither physically possible) for all ski areas, and a similar problem may arise when deciding to dismantle a ski resort in order to divert tourist destination to another area.

² The calculation of the national territory included in the scope of the Alpine Convention can be found in EURAC, *Collectio – Convenzione delle Alpi*, 2005, 32.

³ The Italian Alpine regions are – from West to East – Valle D'Aosta, Piemonte, Lombardia, Veneto, Autonomous Province of Trento, Autonomous Province of Bolzano/Südtirol, Friuli Venezia-Giulia.

2. Methodological details

As already anticipated, a certain lack of harmonization appears to exist in Europe regarding the terminology used for defining ski areas and ski resorts. In addition, ski resorts are not always included in wider ski areas. This happens in Italy as well: since not all Italian ski resorts are included in a ski area, in order to give a more complete picture of the situation of winter tourism in the Italian Alps, the data collected refer to ski resorts .

Generally, a ski resort is a location where it is possible to ski but also includes other amenities to make it a destination resort. Those amenities are, for example: accommodations, activities to engage in besides skiing and snowboarding, clubs, cinema, theatre and cabarets.

On the other hand, a ski area is a developed recreational facility containing ski trails and vital supporting services, usually including food, rental equipment, parking facilities and a ski lift system. Ski areas typically have one or more chair lifts for moving skiers rapidly to the top of hills, and to interconnect the various tracks. They can include one or more ski resorts.

Data on ski resorts in the Italian Alps have been checked and collected in collaboration with sectorial industrial associations (such as transportation by rope businesses), and with alpine regional and local authorities.

Most of the data concerning ski facilities (including snowmaking) is owned by private organizations (e.g. businesses running ski and chair lifts and their industrial associations) which, usually, do not make information available for public use, due to competitive and commercial reasons. Certainly, some indication might be extrapolated from tourist centers websites, commercials, etc. Often though, the data reported have not been validated by any public authority (with some encouraging regional exceptions).

According to our inquiries and according to opinions collected from experts involved in this topic, this situation seems to be rather common also in other countries as well. Unambiguous data seem rather difficult to collect.

Since we deemed essential in developing this report to provide officially and institutionally validated data, we have asked public offices having jurisdiction on the matter, to check the datasets used for the analysis and to add any possible information.

In this paper several scientific concepts (such as the so-called “100-day rule”, the “natural snow reliability” of a ski area, etc.) are introduced to illustrate the possible impact of climate change on winter tourism in the Italian Alps: they will be briefly explained when applied in the analysis.

Finally, due to Italian administrative fragmentation, different administrative units (7 Regions and 2 Autonomous Provinces: Trento and Bolzano) might share the very same alpine ski resort. Some ski tracks as well as different facilities, might lay in the administrative border of two different Regions. This is, for example, the case of the Tonale ski area, under the jurisdiction of both Lombardia Region and Trento Autonomous Province, within the Trentino-Alto Adige/Südtirol Region. Similar situations can lead to undesired duplications when calculating data.

Administrative fragmentation does not constitute a problem when analyses are performed at the national level although, according to our inquiry outcomes, aggregated data are rather difficult to find. Furthermore, regional/local administrations and sometimes their statistical departments are the main information providers. The risk of mistakes when calculating total tracks length, facilities number, ski areas or resorts number still exists and are considered in this kind of analyses.

3. Ski areas and ski resorts in the Italian Alps

Besides bigger ski areas that can be found at relatively high altitudes, there are many ski resorts that can be found at lower altitudes.

This fact explains rather well why it is necessary to include the so called pre-alpine areas in the geographic scope of the analysis , in consideration also of the fact that they play a relevant social and economic role in Italy. These areas can mainly be found in the valleys surrounding the bigger Northern Italian cities (e.g. Milano, Torino, Brescia, Verona, etc....) and can be reached – usually by car – in a very short time. Although these cities are not placed at high altitudes, they experienced a rather fast economic development and have become winter tourism destinations with a positive economic impact on local industry (e.g. trade, housing ...). They also brought a positive reduction of mountain depopulation by creating new job opportunities and by supporting the winter tourism industry. Recently, all these localities have been losing ground because of decreased snow precipitations and shorter winter season.

According to the collected data , Italian Alps ski stations and single ski centres are 251, provided with 1464 facilities (including ski lifts, chair lifts, tapis roulants, etc.). Even though there are some larger ski areas (e.g. Sestriere, Dolomiti Superski, etc.) where a higher number of facilities can be found, a great number of ski stations have only a limited economic impact being made of only three or less ski facilities.

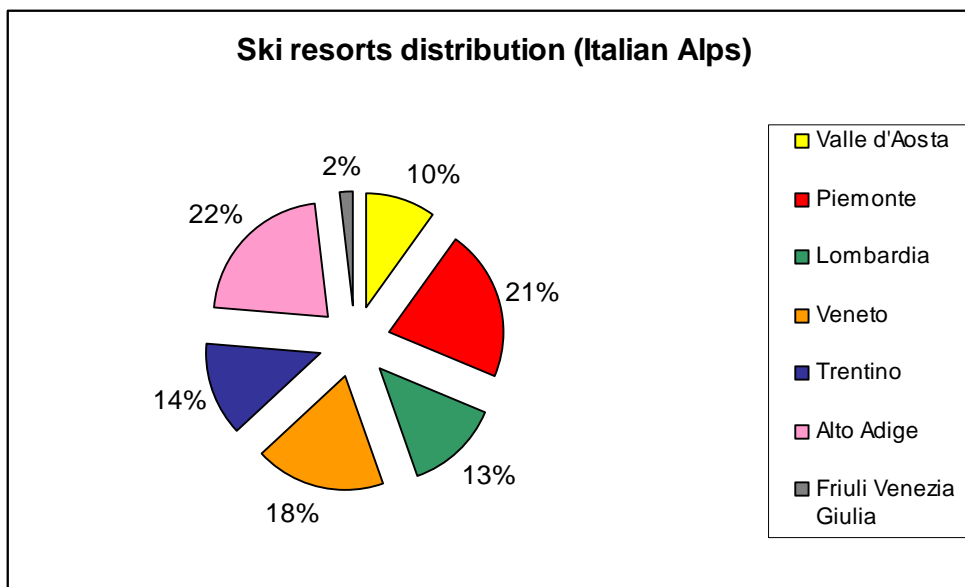


Fig. 1 – Ski resorts distribution in the Italian Alps (including pre-alpine areas). Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

Number of ski resorts in Italian Alps⁴	
Valle d'Aosta ⁵	25
Piemonte ⁶	54
Lombardia ⁷	33
Veneto ⁸	46
Trentino ⁹	34
Alto Adige ¹⁰	54
Friuli Venezia Giulia ¹¹	5
Tot. Ski resorts (Italian Alps)	251

Table 1 – Ski resorts distribution in the Italian Alps. Data source: ANEF spiegare sigla (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

As shown by the data reported above, Piemonte and Alto Adige/Südtirol are the Regions hosting the highest number of ski resorts in the country (108 out of 251).

In case of climate change, the development of appropriate indicators become important to understand how winter season duration is likely to vary. This variation can lead certain areas to be excluded from profitable winter sport activities and suggest the use of some adaptation strategies. To this end, information concerning the mean altitude ranges of Alpine ski areas is of great importance.

The present analysis is based on average of altitudes of Italian alpine ski areas¹². If climate change was to occur and result in a rise of temperature from 1 to 4°C, the natural conditions to profitably run ski facilities would change. Lower altitude ski areas are subject to the risk to become unable to host winter sport activities.

The average of MIN, MAX, MEAN altitudes of and the altitudinal difference (MAX – MIN) in single ski resorts for the seven Italian alpine regions have been calculated (per geographical location) and gathered in the following table.

Average of altitudes of ski resorts in the Italian Alps	MAX	MIN	MEAN	Altitudinal difference (MAX – MIN)
Italian Alps	2072	1314	1689	758
Valle d'Aosta	2308	1512	1910	796
Piemonte	1918	1250	1554	668
Lombardia	1987	1354	1671	633
Veneto	1934	1353	1644	581
Trentino	1966	1428	1697	538

⁴ The data we provide here refer to “ski resorts” since in Italy not any ski resort is included in a wider “ski area” and an analysis focused on ski areas could not provide an accurate picture of the concrete situation of the Italian Alps

⁵ Data provided by ANEF – Associazione Nazionale Esercenti Impianti a Funne” – association of the businesses running ski lifts in Italy. The ANEF data refer to winter 2004/2005.

⁶ Data provided by Regione Piemonte, refer to summer 2003.

⁷ Data provided by ANEF

⁸ Data provided by ANEF

⁹ Data provided by ANEF

¹⁰ Data provided by Provincia Autonoma di Bolzano, refer to 2005

¹¹ Data provided by Regione Friuli Venezia Giulia, refer to 2005

¹² The main sources for data used in this paper are: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

Alto Adige	2497	1316	1906	1181
Friuli Venezia Giulia	1894	985	1439	909

Table 2 – Max, Min, mean and Max-Min difference for altitudes in the Italian Alpine regions. Elaboration: EURAC according to OECD criteria. Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

Some remarks can be made in order to facilitate the interpretation of these data.

Under a general point a view, the higher the minimum altitude of ski resort is, the better it gets in terms of capability to adapt to climate change. This means that the resorts:

- reaching a higher altitude;
- starting at a higher altitude;
- having a bigger difference between their max and min altitude

are likely to suffer less from even a critical rise in average temperature.

According to the data reported above, a rather favourable situation can be expected for some of the Italian alpine Regions such as Valle d'Aosta (high min altitude, high max altitude), Trentino (high min altitude), Lombardia (rather high min and max altitude) and Provincia Autonoma di Bolzano/Südtirol (high max altitude and bigger difference between max and min altitude).

On the other hand, areas with lower min and max altitudes will suffer more in case of climate change, as it is the case for the Friuli Venezia Giulia.

4. Possible impact of climate change on winter tourism in Italy

The financial viability of winter tourism industry depends to a great extent on favorable snow conditions and on natural snow reliability of its ski areas.

This concept has been deeply investigated. It refers to the so-called 100-day rule, stating that in order to successfully operate a ski area, a snow cover sufficient for skiing should last at least 100 days per season.

However, this rule is not always applicable and has to be seen only as a working tool. It is important to remind that specific local conditions can make economically profitable to run ski facilities and to manage the winter season even if the rule is not respected within a certain area.

A certain amount of snow is required to groom the slopes, to protect the ground, to guarantee a safe operation, and to offer the skiers an enjoyable experience. From an operational point of view, the minimum snow depth depends on the nature of the slopes. In general, a snow depth of 30 cm is considered as sufficient (Witmer 1986).

Naturally, a ski resort can be considered snow-reliable when its physical conditions (such as snow depth, consistency, etc.) and winter season length are consistent with the 100-day rule.

Since snow precipitations and climate conditions change with altitude, the snow reliability of a ski resort usually depends on its geographic location in the Alpine arc and on its altitude. Therefore an ideal line can be traced that adequately take into consideration those natural conditions. This ideal line is called line of natural snow-reliability (LSR).

As anticipated above, the line of natural snow reliability (LSR) varies across the Alps. Colder Regions have the LSR at lower altitudes than warmer Regions. Italian Alps are under the beneficial effects of the

Mediterranean Sea showing, in general, a LSR at a lower level compared with the other Countries of the alpine arc.

In a warmer climate, it is estimated that the snowline, as well as the line of natural snow reliability, will rise by 150 m per 1°C warming (Föhn 1990, and Haerberli and Beniston 1998).

In this paper a particular ski area is considered to be naturally snow-reliable, if the upper half of its altitudinal range is located above the threshold value for the line of natural snow-reliability. This assumption is based on the fact that the main ski operations usually take place in the higher parts of the ski areas.

According to recent studies concerning the effects of climate change in the Alpine area, in regions where the natural line of snow reliability is currently at 1500 m, the altitude for snow reliability will increase:

- to 1650 m (if temperature rises by 1°C).
- to 1800 m (+2°C)
- to 2100 m (+4°C).

According to the above mentioned data, Valle d'Aosta, Alto Adige/Südtirol and Trentino are the two Regions more likely to be damaged by forecasted increase of the natural line of snow reliability.

In consideration of the lower mean altitudes of ski resorts in Friuli Venezia Giulia, this Region might, not only be exposed to damages, but seriously at risk

In order to apply this forecast, the analysis proceeded as follows:

1. identification of all the Italian ski stations whose average of the altitudes was higher than 1500, 1650 and 2100 m;
2. calculation of how is the current situation going to change in the following years

That done, we found the situation reported in the table and figure below:

Snow reliable ski stations	>1500 (UCC)	>1650 (+1°C)	>1800 (+2°C)	>2100 (+4°C)
Valle d'Aosta	22	20	16	5
Piemonte	30	22	16	6
Lombardia	21	14	11	6
Veneto	14	12	8	2
Trentino	25	17	14	4
Alto Adige	54	46	23	7
Friuli Venezia Giulia	1	0	0	0
Italy	167	131	88	30

Table 3 – Snow reliability of ski resorts in the Italian Alps, per Region. Elaboration: EURAC according to OECD criteria¹³. Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

¹³ The 100 days rule is applicable as a working tool for medium to large ski areas where a benchmark of 100 days operations per season is used for financial viability. The analysis includes a number of smaller ski resorts (with less than 3 transport facilities), although the trend is similar to the OECD analysis which considered only medium to large ski areas.

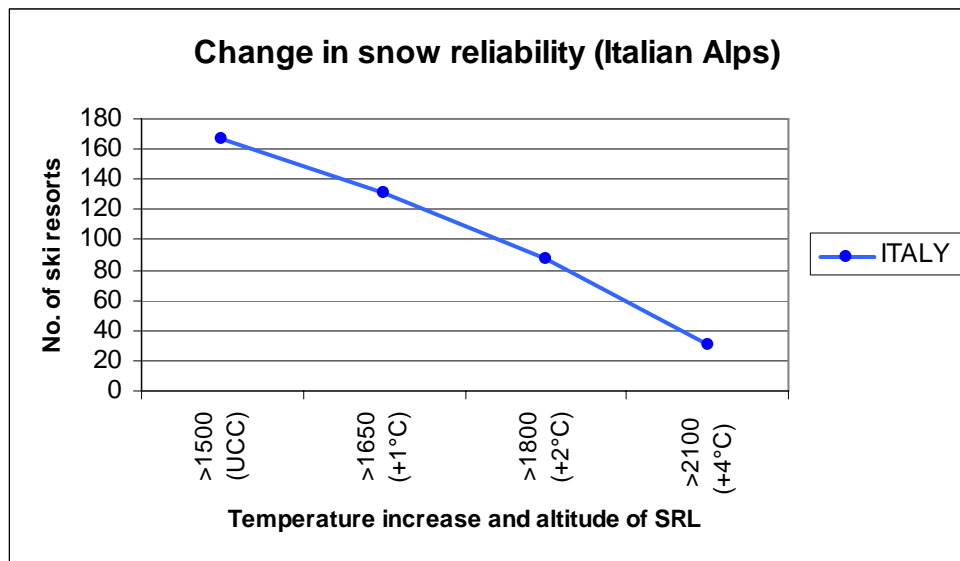


Fig. 2 Change in snow reliability in the Italian Alps (%). Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

Considering the first option analyzed in case of climate change (+1°C and line of natural snow reliability [LSR] at 1650 m), the alpine Regions which are likely to be more affected are Friuli Venezia Giulia, where all the ski resorts would go under the LSR as well as Lombardia, Trentino and Piemonte, where the 33, 32 and 26% of ski resorts respectively would move under the line of natural snow reliability. A further increase of 1°C (+2°C, SRL at 1800 m) would mainly affect Alto Adige/Südtirol and Veneto, where 50 and 33% of the remaining snow reliable ski resorts, respectively, would move under the LSR. The situation depicted in third scenario (+4°C, SRL at 2100 m) reduces ski resorts over the LSR to only 30, in the whole Italian Alps – that is down by 18% of the current situation - showing main impacts on ski resorts in Veneto, Trentino and Alto Adige, where 75, 71 and 69% of ski resorts would move under the LSR.

As a result, the analysis found that the Italian Regions where the impact of climate change on LSR appears to be less intense are Lombardia and Valle d'Aosta. .

The trend illustrated in the figure above (Fig. 2) summarizes the outcomes of the present analysis for the whole Italian Alpine arc. The situation that can be observed suggests how strongly climate change is likely to impact on winter tourism industry in Italy. According to the scientific study on which the present analysis was based:

- in case of a 1°C rise in temperature, almost 20% of the existing alpine ski resorts would be no longer snow reliable;
- in case of a 2°C rise in temperature, almost 40% would lose their snow reliability;
- in case of a 4°C rise in temperature, the snow reliable ski resorts would fall to 18% compared with the actual situation.

5. Snowmaking facilities

It is difficult to collect official data on snowmaking facilities, since many are not fixed to the ground and can be moved and used where and when needed. Even though these facilities need specific permits and have to follow strict criteria, a public register does not exist. Often, snowmaking facilities are prone to fast obsolescence and are subject to a rapid turnover.

It is only in recent years that a public register for them was at least foreseen. This should be systematic and computer-based.

No comprehensive statistical datasets are available for all the Italian alpine Regions and a risk of under / overestimation of this dimension does exist, depending very much on the source used.

Even though websites to inform tourists can sometimes appear as the main (even though unsatisfactory) source of information on ski areas and winter tourism facilities, they provide rather unspecific information on the snowmaking facilities coverage and do not clarify how many snow-cannons or other machines are used within a certain ski area. It has to be noted that tourist information often give an overestimation for commercial reasons, in contrast with the data provided by environmental impact assessments snowmaking facilities coverage. This makes quite uncertain, for example, any generalization concerning water consumption for snowmaking activity.

The present analysis was able to collect a remarkable amount of data from administrative sources (that is from Regional authorities) as well as from sectoral industrial associations. The analysis covers almost the whole Italian Alpine area, even if sometimes information was incomplete and not all ski resorts did provide necessary data. However, with reference to artificial snowmaking in some Italian regions data are complete (e.g. Valle d'Aosta, Alto Adige/Südtirol).

According to our data, 76,9 % of the Italian Alpine ski stations are equipped with artificial snowmaking facilities.

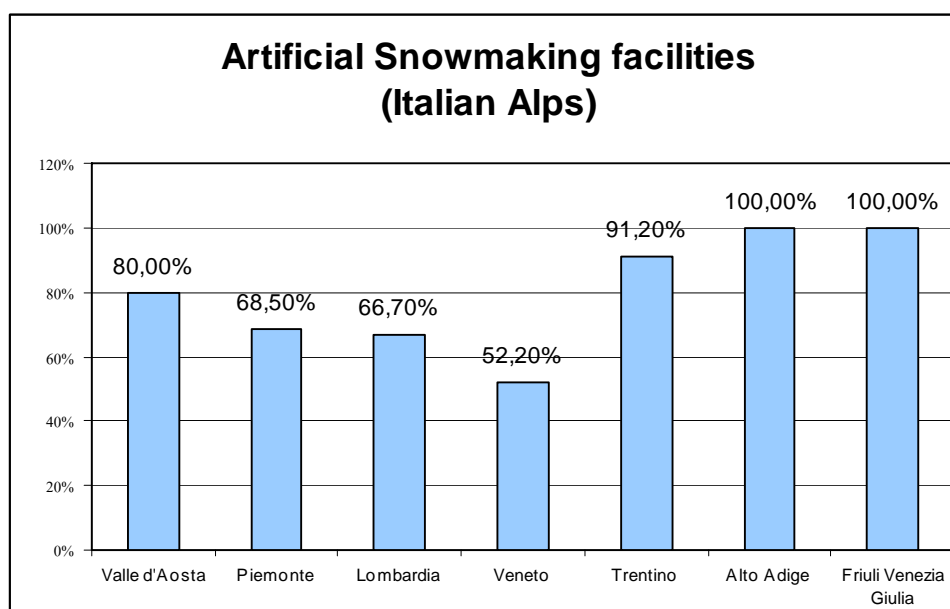


Fig.3 – Endowment of Italian Alpine ski resorts with artificial snowmaking facilities (%). Elaboration: EURAC. Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

Ski runs with artificial snow facilities	No. of ski areas with artificial snowmaking facilities	No. of ski areas (TOTAL)	Ski areas with artificial snowmaking facilities (in %)
Valle d'Aosta	20	25	80,0%

Piemonte	37	54	68,5%
Lombardia	22	33	66,7%
Veneto	24	46	52,2%
Trentino	31	34	91,2%
Alto Adige	54	54	100,0%
Friuli Venezia Giulia	5	5	100,0%
Total (No. / %)	193	251	76,9%

Table 4 – Endowment of Italian Alpine ski resorts with artificial snowmaking facilities, per region. Elaboration: EURAC. Data source: ANEF (2005), Regione Piemonte (2003), Provincia Autonoma di Bolzano (2005)

BOX

Physical extension of artificial snowmaking in Valle D'Aosta, Provincia Autonoma di Bolzano/Südtirol and Friuli Venezia Giulia

Additional detailed data are available concerning three Italian Alpine Regions: Valle D'Aosta, Provincia Autonoma di Bolzano/Südtirol and Friuli Venezia Giulia. The information provided in the following table and figure refer to the physical extension of regional ski domain and can help to determine the surface covered by artificial snow.

Italian Alpine Region	Total ski domain	Ski domain covered by artificial snowmaking	Ski domain covered by artificial snowmaking (%)
Valle d'Aosta	1305,7 ha	647,2 ha	49,6%
Provincia Autonoma di Bolzano	3779,7 ha	2233,3 ha	59,1%
Friuli Venezia Giulia	241 ha	236 ha	98%

Table 5 – Ski domain covered by artificial snowmaking in the Italian Alpine ski resorts, for three alpine regions (ha; %). Elaboration: EURAC. Data source: Regione Autonoma Valle D'Aosta (2005), Regione Friuli Venezia Giulia (2005), Provincia Autonoma di Bolzano (2005)

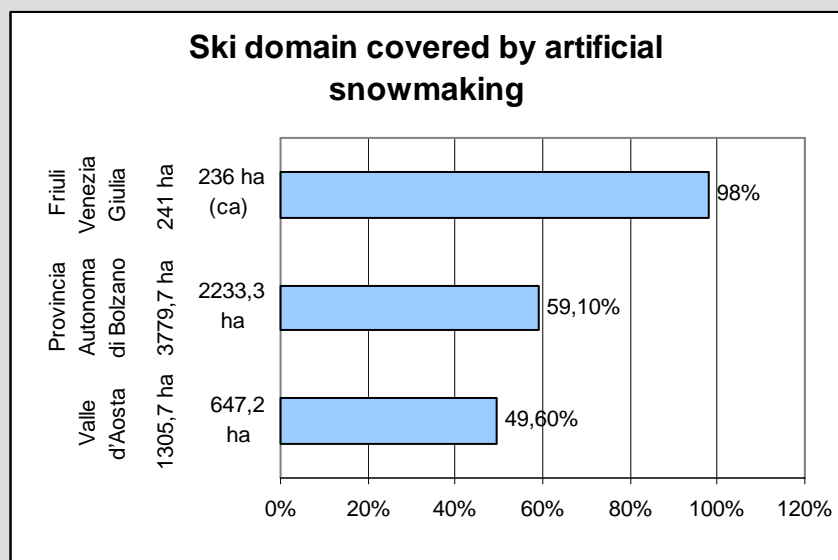


Fig. 4 – Ski domain covered by artificial snowmaking in the Italian Alpine ski resorts, per region, for three alpine regions (ha; %). Elaboration: EURAC. Data source: Regione Autonoma Valle D'Aosta (2005), Regione Friuli Venezia Giulia (2005), Provincia Autonoma di Bolzano (2005)

6. Existing regulations on artificial snowmaking

In Italy, national specific regulations on artificial snowmaking have not yet been provided.

The competence over this matter relies mostly on regional and local authorities. Even though the construction of new facilities may require an environmental impact assessment depending on the dimension of the facility and according to national law, a comprehensive legal tool dealing with this matter has not yet been issued.

A rise in public concern on artificial snowmaking environmental impact and awareness on its economic cost can have a catalytic role in developing specific local regulations.

Generally speaking, in Italy an authorization procedure is requested for facilities installations which have meaningful territorial and environmental impact. In ski areas wider than 2 ha a specific impact assessment for installations has to be made. For example, this is the case for the Trento Autonomous Province (Provincia Autonoma di Trento).

At present, in order to stress the efforts that have been made in this direction at regional level, it is possible to recall, for example, the specific regulation issued by the Autonomous Province of Bolzano (Delibera della Giunta Provinciale N. 2691 issued on July, 25, 2005). This act foresees the chemical analysis of water used for artificial snowmaking; the prohibition to add other substances to the water used; specific controls to be made by the manager of the snowmaking facility according with quality criteria; building of apposite water towers.

7. Conclusive remarks

The data included in this report provide a rather general overview of the situation of winter tourism in the Italian Alps, including scenarios on climate change impacts. Our analysis focused on ski resorts and was based on regional data, made available by regional authorities and industrial associations. The resulting picture is quite interesting to understand the general situation of the Italian Alps with reference to winter tourism, ski facilities and ski resorts. In addition, the analysis provided further data highlighting the presence of ski resorts also at lower altitude. Some basic information have also been made available on existing snowmaking facilities.

In the Italian Alps, according to a reliable assessment, there are nearly 250 ski resorts and more than 1400 ski facilities. Lower altitude resorts host ski facilities and correlated tourist facilities and activities. Some of these centres are located in the pre-alpine region (Prealpi). Not far from the main cities of northern Italy, they can be reached within a very short time. In case of rise of temperature due to climate change, such resorts are likely to be damaged: winter tourism located at low altitude is under threat.

Starting from these data, calculations have been performed in order to determine the LSR altitude variation and to see how it is likely to impact on the Italian alpine ski resorts.

Even though the "100-day rule" mentioned above can not be considered but a useful working tool, the main outcomes of this analysis show that climate change impact on winter tourism in the Italian Alps is likely to be remarkable.

The present report has shown that out of 251, only 167 of the Italian ski resorts (66%) are over the LSR but the number is going to diminish substantially in case of even slight changes in air temperature (52% in case of +1°C; 35% in case of +2°C and only 12% in case of +4°C).

Despite the problems in collecting reliable data and the lack of complete information, apparently most of the alpine ski resorts seem to use artificial snowmaking facilities for ensuring the cover of ski tracks

A national integrated legal regulation on artificial snowmaking has not yet been issued. A few encouraging initiatives can though be found at the local level, where the authorities having jurisdiction have issued acts on this matter, taking also into consideration the impact that these facilities can have in terms of water consumption and use of chemical additives.

8. Main sources

EURAC, Collectio – Convenzione delle Alpi (2005)

EEA (European Environment Agency) (2005), Vulnerability and adaptation to climate change in Europe., Technical Report No7/2005, Copenhagen, Denmark.

Official web site of the Alpine Convention: www.convenzionedellealpi.org

Data concerning ski facilities, tracks and artificial snowmaking have been provided by:

- ANEF, Associazione Nazionale Esercenti Funiviari, Censimento Impianti a fune – Inverno 2004/2005
- ISTAT website: [http:// www.istat.it](http://www.istat.it) for winter tourism data
- Regione Autonoma Valle D'Aosta (2005)
- Regione Friuli – Venezia Giulia (2005)
- Regione Piemonte (2003)
- Provincia Autonoma di Bolzano/Südtirol (2005)