

Do tourism-based ski resorts contribute to the homogeneous development of the Mediterranean mountains? A case study in the Central Spanish Pyrenees

Teodoro Lasanta, María Laguna, Sergio M. Vicente-Serrano*

Instituto Pirenaico de Ecología, Spanish Council Research (CSIC). Campus de Aula Dei. Apdo. 202, 50080- Zaragoza, Spain

Received 12 June 2006; accepted 15 January 2007

Abstract

Tourist activities, especially those related to skiing, have been promoted in the central Spanish Pyrenees since the 1950s. Using a 30-year data set extending back to before the development of most ski resorts in the Pyrenees, we analysed the effects of ski resort development on the human population (change in the number of inhabitants, demographic structure and structure of the working sector) and the primary production activities of the area (number of farms and livestock). Spatial differences that have occurred in the socioeconomic changes since ski resort construction began are also analysed. Results show that the area influenced by ski resorts is restricted to the municipalities nearest to them. These municipalities show positive demographic changes and a negative evolution of primary activities. The municipalities more distant from the ski resorts show the opposite pattern. The advantages and problems of ski resort-based tourism in relation to the sustainable development of the Pyrenees are discussed in depth.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Ski resorts; Tourism; Regional development; Mediterranean mountains; Pyrenees; Spain

1. Introduction

Beginning in the 1950s, the Mediterranean mountains have become increasingly developed to cater for tourist activities. This was partly a result of traditional practices (livestock, agriculture, forestry) being unable to generate enough income to maintain farms and social structure (André, 1998; Godde, Price, & Zimmermann, 2000). The tourism-based development strategy of modifying land management practices to incorporate tourism infrastructure has followed that observed in the Alps some decades earlier (Brugger, Furrer, & Messerli, 1984; Knafou, 1978; Zimmermann, 1994).

The development of tourism infrastructure in Europe in general has been achieved in several ways, including:

- diversifying farm activities to include providing tourist services such as accommodation and catering (Walford, 2001).

- the creation of companies devoted to outdoor activities such as climbing and other adventure sports (Beedie & Hudson, 2003; Hudson & Miller, 2005; Pomfret, 2006).
- the exploitation of landscapes and natural resources such as national parks (Abrudan & Turnock, 1998; Mules, 2005).
- the development of ski resorts (Moser & Moser, 1986; Price, 1987).

These approaches are often used simultaneously in a region to maximise tourist attraction. In the Spanish Pyrenees, however, ski resorts have dominated, and the other approaches have had limited capacity to create significant revenues (Laguna & Lasanta, 2001).

Ski resort-based tourism development brings many benefits to a region, including economic and income diversification, improvement of services and infrastructure, and the creation of “psychological stability” among residents (Barbier, 1993; Lindberg, Andersson, & Dellaert, 2001; Snowdon, Slee, Farr, & Godde, 2000). However, there are also several negative impacts, including environ-

*Corresponding author. Tel.: +34976716141; fax: +34976716019.
E-mail address: svicen@ipe.csic.es (S.M. Vicente-Serrano).

mental damage (Bentham, 1973; García-Dory, 1977; Needham & Rollins, 2005; Schwarzl, 1991), landscape changes (Pignatti, 1993), social confrontation between those who support and reject tourism (Gill & Williams, 1994; Smith & Krannich, 1998; Tooman, 1997; Weaver & Lawton, 2001), and degradation of cultural and urban heritage (Billet, 2003; Haimayer, 1989; Jamal & Getz, 1999; Kariel, 1989).

The effects of ski resorts on regional development are less well known, and many questions remain unanswered. For example, is ski-resort tourist growth a sustainable and balanced development for the management of the territory? Or, does ski resort development favour one economic sector to the detriment of others? Does this development benefit only a few municipalities, or do benefits permeate over a greater area? This study attempts to answer these questions for the Spanish Pyrenees, an area representative of the widespread evolution of tourism-based economies currently occurring in much of the European Mediterranean mountainous areas.

Determining the effects of tourism on the local population (number of inhabitants and demographic structure) and on primary production activities (farming practices and number of livestock) were the specific aims of this study. These variables were chosen as they are considered indicators of the development model created at the Spanish Pyrenees.

2. Study area

The study area is located in the central Spanish Pyrenees (Fig. 1). The region has a surface area of 3278 km² and in 2001 had 12,964 permanent inhabitants. There are 36 municipalities in the study area. The central Spanish Pyrenees comprises several parallel valleys aligned in a N–S direction. Steep slopes surround the plain areas at the

bottom of the valleys (García-Ruiz & Sala, 1984). A large percentage of the study area is above 2000 m in elevation. The mean annual 0°C isotherm occurs at 2726 m but during winter it descends to 1700 m (Del Barrio, Creus, & Puigdefábregas, 1990). Therefore, snow is very frequent during the winter months, and the ground is snow-covered for 7–8 months of the year although with important differences between years (López-Moreno & García-Ruiz, 2004).

Intensive land exploitation has been widespread in the Pyrenees (García-Ruiz & Lasanta, 1990). The bottom valleys and the low southern slopes were farmed for cereals for human consumption. There were coniferous forests (*Pinus sylvestris*) on the northern slopes and deciduous forests (*Quercus faginea*) on the southern slopes between 1000 and 1600 m from which wood was obtained. The summer pastures were located above the forests (>1600 m), and were used to feed livestock, and some of these still remain today. The properties are communal and free for farmers to use (Puigdefábregas & Fillat, 1986).

The main economic output of the Pyrenees comes from the summer pastures. They are capable of providing feed for more than 60,000 sheep from June to September, which corresponds to the estimated number of livestock maintained in the Pyrenees during the nineteenth century (Ferrer, 1988). However, the summer pastures are snow-covered for up to 8 months a year (from October to June), and during these months the livestock must be fed in other areas. Traditionally, the livestock were maintained thanks to a transhumant system that involved moving stock to the centre of the Ebro valley during the winter where uncultivated areas and agricultural lands were used for grazing (García-Ruiz & Lasanta, 1993).

During the twentieth century, however, the transhumant system was disrupted as a consequence of agricultural

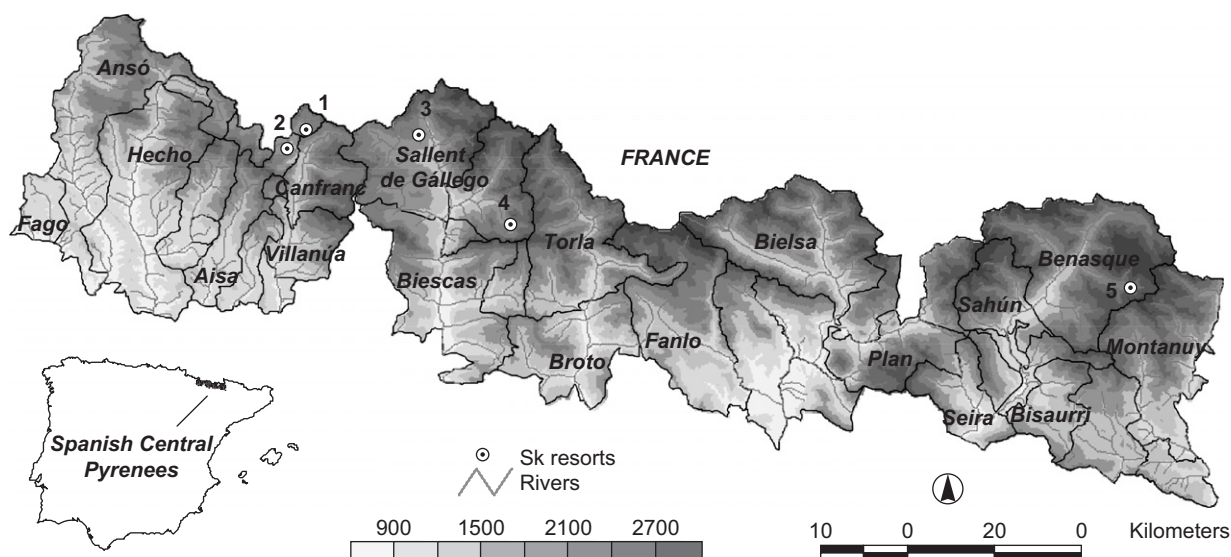


Fig. 1. Location of the study area and relief distribution (meters). The municipalities and the location of the different ski resorts are shown: 1. Astún, 2. Candanchú, 3. Formigal, 4. Panticosa-Los Lagos, 5. Cerler.

Table 1
Characteristics of the ski resorts of the central Spanish Pyrenees

	Astún	Candanchú	Cerler	Formigal	Panticosa-Los Lagos
Municipality	Canfranc-Jaca	Aísa	Benasque	Sallent	Panticosa
Year of construction	1971	1962	1971	1965	1970
Km with ski courts	41	59	60	83	34
Number of courts	48	53	51	71	38
Number of ski lifts	14	23	29	23	15
Users/hour	16,908	21,300	24,920	34,054	13,355
Snow cannons	120	134	312	282	100
Maximum elevation (m)	2300	2400	2630	2258	2200
Minimum elevation (m)	1700	1530	1740	1740	1500
Range	600	870	890	518	700
Accommodations (ski resort)	520	1174	879	1688	676
Accommodations (municipalities near of the ski resort)	10,250	10,538	4531	6354	6647

intensification in the centre of the Ebro valley. Accommodating the loss of this over-wintering resource involved decreasing the number of livestock kept in the area (from 68,230 to 21,899 sheep; Ferrer, 1988), which was responsible for the disappearance of a number of farms (e.g. in the municipality of Bielsa, there were 114 farms in 1954 but only 39 in 1972).

The livestock decrease coincided with a period of industrial growth in the cities, which fuelled the emigration of rural populations, especially those in mountainous areas (Caravaca & Méndez, 1994). The central Spanish Pyrenees lost 38% of its inhabitants (decreasing from 24,735 to 15,392) between 1950 and 1970.

Within this social and economic framework, the creation of ski resorts was considered one solution to help stop the economic retreat and instead favour the development of this region. Between 1961 and 1970, five ski resorts were created in the study area: Candanchú, Astún, Formigal, Panticosa-Los Lagos and Cerler (see locations in Fig. 1 and their main characteristics in Table 1).

3. Methods

Data used in this study were obtained from several public organisations. The number of inhabitants, number of primary production farms, and number of livestock were obtained at the municipal level from the National Statistics Organisation. The number of tourist facilities was provided by the Regional Government, which maintains an ongoing municipal database.

For each municipality, we obtained data from two years, 1970 and 2000, to quantify the change during this period. These data include the number of inhabitants, population structure (age structure and work sector characteristics), number of livestock, number of primary farms and number of beds in tourist facilities (hotels, apartments, second homes, mountain lodges, rural houses, and camping sites). Information of this kind prior to 1970 does not exist, so it was only possible to examine population size before this point. While several ski resorts were built prior to 1970, the Pyrenees underwent the majority of its economic and social

change during the studied period (1970–2000), and we thus consider this period adequate for the quantification of the effects of widespread ski-resort installation.

We used two indicators of tourist load: (i) the number of tourist beds in each municipality (5 beds for each second home and 0.1 for each camping site) and (ii) the Defert's Tourist Function Rate (DTFR) (Defert, 1967), which is often used in tourism studies (e.g., Smith, 1995; Laguna & Lasanta, 2003). This rate is obtained by the formula:

$$DTFR = \frac{X}{Y} \times 100, \quad (1)$$

where X is the number of tourist beds and Y is the number of inhabitants in the municipality.

To determine the demographic structure, we used three indices:

- (i) Rate of young people (the number of people less than 16 years of age as a proportion of the number of people older than 64 years).
- (ii) Rate of aging (the inverse of i).
- (iii) Dependence index (the non-working population compared to the working population. The former is considered to be those <16 and >64 years while the latter is considered to be those between 16 and 64 years).

To take into account the capacity of ski resorts to be more or less attractive to tourists, we developed a ski resort attraction index (SRAI) that considered the distance between the ski resort and the municipalities (in minutes of driving time) and the tourism capacity (skiers/hour) of each ski resort. The index is calculated using the formula:

$$SRAI = \sum_{i=1}^n (0.1/D_{i \rightarrow j})(C_j/1000), \quad (2)$$

where D is the distance in number of driving minutes (considering average speed as a function of the type of road) from the ski resort i to the municipality j . C is the number of skiers/hour corresponding to the ski resort j .

The first term (D) exhibits exponential decay. As such, short distances will score relatively highly on the index, corresponding to good access to the ski resort. However, as distance increases we consider that attractiveness will become asymptotic over a certain distance and its influence on the index score will be lower than for low D values. We thus established a limit in the calculation procedure of $D > 90$ min. Over this threshold, we used a value of 0 because the distance to the ski resort is too long to affect the socioeconomic conditions of the municipality.

The relationships between the spatial distribution of the different economic and social variables in the municipalities and the SRAI were analysed using bivariate statistics. We used the software TableCurve 2D v5.01© for all analyses. The method followed a refitting procedure in which all points outside the 90% prediction interval were removed and the curves refitted (the removed points are circled in the figures). Linear and simple non-linear relationships were considered, selecting the more suitable model for the data.

4. Results

4.1. Tourist evolution (1970–2000)

Table 2 shows the evolution of the DTFR and the number of tourist beds between 1970 and 2000 for the entire study area. Both indicators show significant increases of 127.9% and 163% for the DTFR and the number of tourist beds, respectively.

Fig. 2 shows the spatial distribution of the DTFR (A) and the number of tourist beds (B) in 1970 and 2000 and also the evolution of both parameters during this period. In 1970, the municipalities with ski resorts had high DTFR values and a higher number of tourist beds than other municipalities. In 2000, the spatial pattern was also very close. In relation to the evolution of both parameters, the municipalities located near ski resorts showed the most important increases (e.g., Biescas had a DTFR of 191 and 2473 beds in 1970, and in 2000 had a DTFR of 788 and 10005 beds; Villanúa had a DTFR of 310 and 822 beds in 1970, and in 2000 had a DTFR of 1106 and 5749 beds).

4.2. Influence of ski resorts on the evolution of tourist indicators

Fig. 3 shows the spatial distribution of the SRAI. The highest values are recorded in the municipalities of the

Tena and Canfranc valleys, which contain four ski resorts (Candanchú, Astún, Formigal and Panticosa), with a capacity of 85,617 skiers/hour and 33,789 beds in hotels. The ski resort of Cerler has lower influence, only extending to the municipalities of Benasque and Sahún. This is a small resort (24,920 skiers/hour, 4,531 beds in hotels) and is very far from the other ski resorts.

Fig. 4 shows the relationship between the SRAI and the evolution of the two tourist indicators (DTFR and number of tourist beds) in each municipality between 1970 and 2000. In both cases there is a positive and exponential relationship. With the exception of some outliers, the DTFR and the number of tourist beds increase following high SRAI values, with coefficients of determination of $R^2 = 0.41$ and 0.66 , respectively. Therefore, 41% and 66% of the spatial variability in the evolution of each indicator, respectively, is explained by the spatial distribution of the SRAI.

4.3. Socioeconomic conditions in 1970 and 2000 and their evolution

The socioeconomic evolution in the study area between 1970 and 2000 has been analysed by means of several indicators (Table 3). The total number of inhabitants shows a small decrease from 15,398 in 1970 to 14,018 in 2000. In contrast, the evolution of the demographic structure shows a clear increase in the proportion of people older than 64 years, a decrease of those younger than 16 years, and a decrease in the values of the dependence index, mainly as a consequence of the sharp decrease of the proportion of the young people. Among the work sector categories, there was a decrease in workers in the primary sector (43.5%) and an increase in the tertiary sector (73.9%). The number of primary production farms also decreased (by 21.4%), although the number of livestock per inhabitant showed a general increase. Nevertheless, if this is analysed at the municipal level there was a high spatial diversity.

4.4. The influence of ski resorts on socioeconomic changes (1970–2000)

4.4.1. Population, demography and the structure of the working sector

Fig. 5 shows that in 1970 the spatial distribution of the populations was not related to the SRAI. In contrast, in 2000 the spatial distribution of the SRAI explained 43% of the spatial distribution of the population within the study area.

The relationship between the evolution of the number of inhabitants in each municipality and the SRAI is not strong, although it is statistically significant. The municipalities that lost more people between 1970 and 2000 coincide, in general terms, with those municipalities that have low SRAI values. On the contrary, the most

Table 2
DTFR and number of tourist beds in 1970 and 2001

Indicators	1970	2001	Percentage
DTFR	223	531	127.89
Number of beds	28,298	74,435	163.04

The last column indicates the % of each indicator in 2000 in relation to 1970.

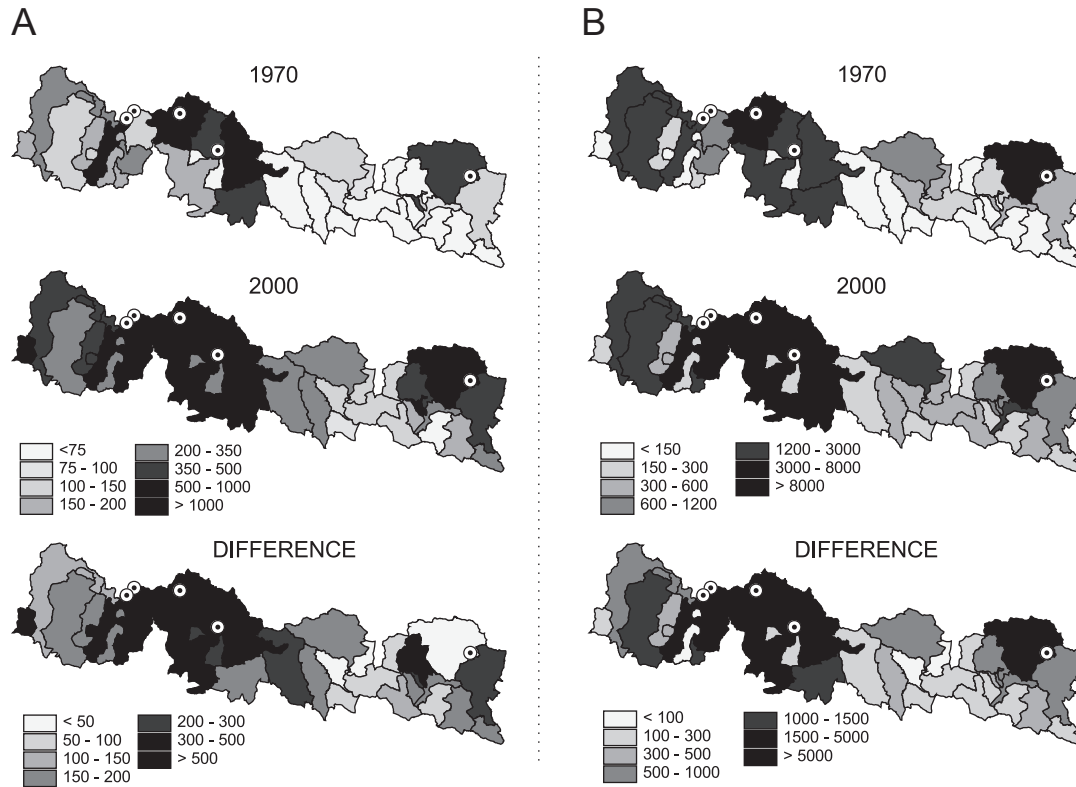


Fig. 2. Spatial distribution of the (A) DTFR in 1970, 2000 and the evolution between 2000 and 1970, (B) number of tourist beds in 1970, 2000 and the evolution between 2000 and 1970.

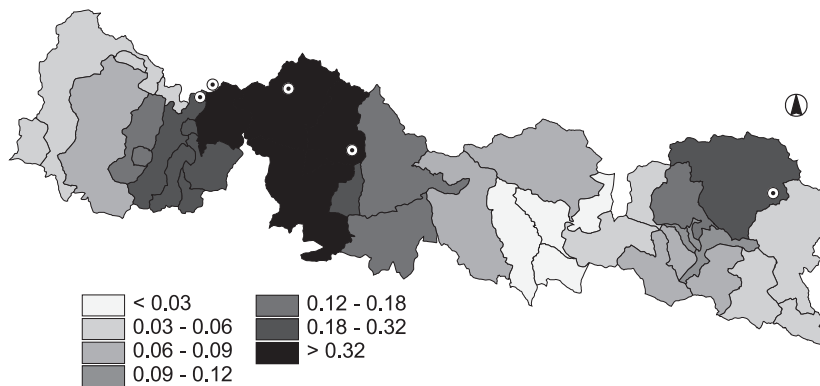


Fig. 3. Spatial distribution of the ski resort attraction index (SRAI).

important increases in the number of inhabitants are recorded in those municipalities with high SRAI values.

Fig. 6 relates the demographic structure and the SRAI. The rate of young people shows a positive exponential relationship with the SRAI in both 1970 and 2000. Nevertheless, the rates were higher (1–3) in 1970 than in 2000 (0–1). This reveals a general decrease in the percentage of young people across the region during this period, although higher SRAI values usually coincide with a higher rate of young people.

In relation to the aging rate, in 1970 and 2000 higher values were mainly recorded in the municipalities with low

SRAI values. The relationship between the spatial distribution of the SRAI and the aging rate is stronger in 2000 ($R^2 = 0.31$) than in 1970 ($R^2 = 0.22$), suggesting that ski-resorts are having increasing influence on this indicator.

The spatial distribution of the dependence index had no relationship with the SRAI in 1970, whereas in 2000 there was a statistically significant negative relationship ($R^2 = 0.24$). This shows that municipalities with high SRAI values have, in general, a lower percentage of non-working people than those with low SRAI values.

The relationship between the evolution of the demographic structure between 1970 and 2000 and the spatial

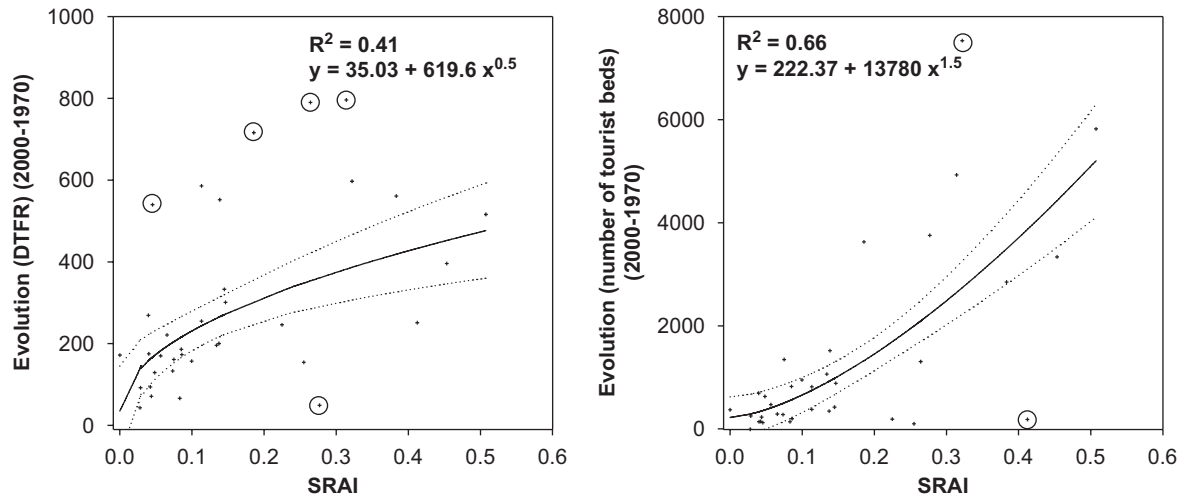


Fig. 4. Relationship between the SRAI and the evolution of the DTFR and the number of tourist beds in each municipality between 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

Table 3
Socioeconomic indicators in the whole study area for 1970 and 2000

Indicators	1970	2000	Percentage
Number of inhabitants	15,398	14,018	−8.96
Rate of young people	1.18	0.40	−66.10
Rate of aging	1.71	3.66	114.04
Dependence index	0.66	0.59	−10.61
% of worker in the primary sector	59.14	33.43	−43.47
% of workers in the tertiary sector	27.20	47.31	73.93
Number of primary production farms per inhabitant	0.14	0.11	−21.43
Number of livestock per inhabitant	1.85	3.5	89.19

The last column indicates the % of each indicator in 2000 in relation to 1970.

distribution of the SRAI shows a stronger relationship between the evolution of the rate of young people and the SRAI ($R^2 = 0.39$). Although the rate of young people decreased over the whole region the decrease has been less important corresponding to high values of the SRAI. The relationship between the SRAI and the evolution of the rate of aging is not significant. In contrast, there is a weak but significant negative relationship between the dependence index and the SRAI ($R^2 = 0.19$).

Fig. 7 shows the relationship between the percentage of primary workers in 1970 and 2000 and the SRAI. The relationship is negative for both years, which indicates that there is a lower percentage of primary workers in the municipalities with high SRAI values. Moreover, the spatial variation in the percentage of primary workers is better explained as a function of the SRAI in 2000 ($R^2 = 0.33$) than in 1970 ($R^2 = 0.26$).

Fig. 8 shows the opposite pattern, since high SRAI values coincide, in general, with a high percentage of tertiary workers. The relationship was strongly positive in both 1970 and 2000, which indicates that the total number

of tertiary workers in each municipality is highly related to the presence of ski resorts.

When the changes observed between 1970 and 2000 are analysed, there is no obvious relationship between the SRAI and the evolution in the percentage of workers in the primary and tertiary sectors. This could be explained by the general decrease in the number of primary workers and the increase in the number of tertiary workers across the study region.

4.4.2. Primary activities

Fig. 9 shows the relationship between the number of primary farms per inhabitant and the SRAI. The figure also shows the relationship between the number of livestock per inhabitant and the SRAI in 1970 and 2000. In 1970 there was no relationship between the spatial distribution of either indicator and the spatial distribution of the SRAI. In 2000, there is a weak but significant negative relationship ($R^2 > 0.2$), which suggests that higher SRAI values are related to a lower proportion of primary exploitations and number of livestock.

Fig. 10 shows the relationship between the spatial differences in the evolution of the number of primary farms per inhabitant between 1970 and 2000 and the spatial differences in the SRAI. Also shown is the relationship between the spatial differences in the evolution of the number of heads of livestock per inhabitant and the SRAI. The spatial distribution in the evolution of both variables is highly related to the spatial distribution of the SRAI. The main decrease in primary activities is recorded in those municipalities that have high SRAI values.

4.5. Other factors that may affect spatial differences in socioeconomic conditions and their evolution

In some cases, the relationships between the SRAI and the socioeconomic indicators in 2000, and the relationships

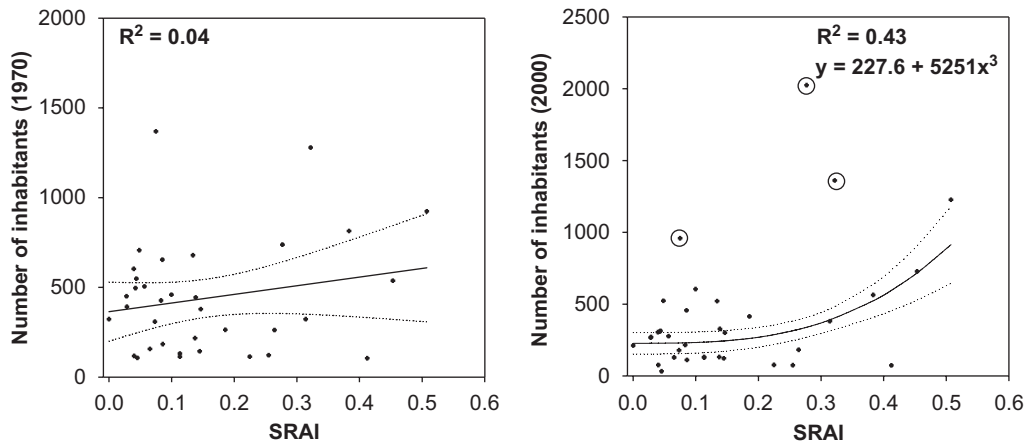


Fig. 5. Relationship between the spatial distribution of the number of inhabitants and the SRAI in each municipality in 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

between the SRAI and the evolution of these indicators between 1970 and 2000, are not very clear. For this reason, in addition to analysing the location and capacity of ski resorts, we also examined the role that other forms of tourism may play. In the central Spanish Pyrenees, the most accessible areas (near principal roads) and some interesting natural landscapes may equate to some municipalities having greater potential to attract tourists than areas that are not well advertised or have limited areas of natural interest. To consider the role of these factors in determining the current socioeconomic conditions and the socioeconomic evolution between 1970 and 2000, we developed a simple indicator [potential tourist conditions (PTC) index] based on the hierarchy of the roads and the location of the most interesting natural landscapes (Fig. 11). The top figure shows the municipalities crossed by wide roads (more than 9m), on which high speed driving is allowed (good asphalt, no sharp bends and tunnels). These roads are catalogued by the Ministry of Public Works as first order roads. In general, the municipalities that contain better roads also contain ski resorts. The municipalities of Bestué and Bielsa are included because they are crossed by the A-138 road that runs between Spain and France. The middle figure shows the municipalities that have areas of high natural and landscape interest, which are recorded in the catalogue of the Regional Government. The lower figure shows the municipalities that have zero, one or two major roads and/or areas of high natural and landscape interest.

For each socioeconomic variable in 2000 and for the evolution between 1970 and 2000, we obtained the residuals corresponding to the bivariate models indicated above (the residual is the difference between the observed and predicted data in each municipality using the SRAI as the predicted variable). In reality, these residuals indicate the non-predicted values (the error) in the spatial distribution of the dependent (socioeconomic) variables as a function of the spatial distribution of the SRAI.

We obtained the average values of the residuals of the socioeconomic variables and their evolution between 1970 and 2000 as a function of the PTC, which summarises the presence of main roads and landscape and natural areas of special interest. Fig. 12 shows the average residual values as a function of the PTC for various socioeconomic indicators. Negative residuals show low values of the socioeconomic variables as a function of their potential according to the SRAI values. Positive residuals show the opposite pattern. Fig. 12 shows that the municipalities that have high PTC values ($PTC = 2$) had fewer livestock, a decrease in livestock numbers between 1970 and 2000, a lower proportion of primary workers and a lower proportion of older people in 2000 than predicted according to their proximity to ski resorts (summarised by means of the SRAI values). The same municipalities ($PTC = 2$) show a higher proportion of tertiary workers, a higher number of inhabitants in 2000, an increase in population size between 1970 and 2000 and a higher proportion of young people. The opposite pattern is observed in the municipalities with low PTC values ($PTC = 0$).

This analysis highlights the importance of tourist activities other than ski resorts for explaining the spatial differences in socioeconomic variables in 2000 and their evolution in the Pyrenees between 1970 and 2000. In general, the spatial variability of socioeconomic variables (and their evolution) not explained by their relation to ski resorts can be related to other factors (summarised by means of the PTC). These factors, therefore, indirectly contribute to the capacity of each municipality to attract tourists.

5. Discussion and conclusions

Beginning in the 1970s, the people in the Spanish Pyrenees have attempted to boost development by improving tourist facilities after traditional land management

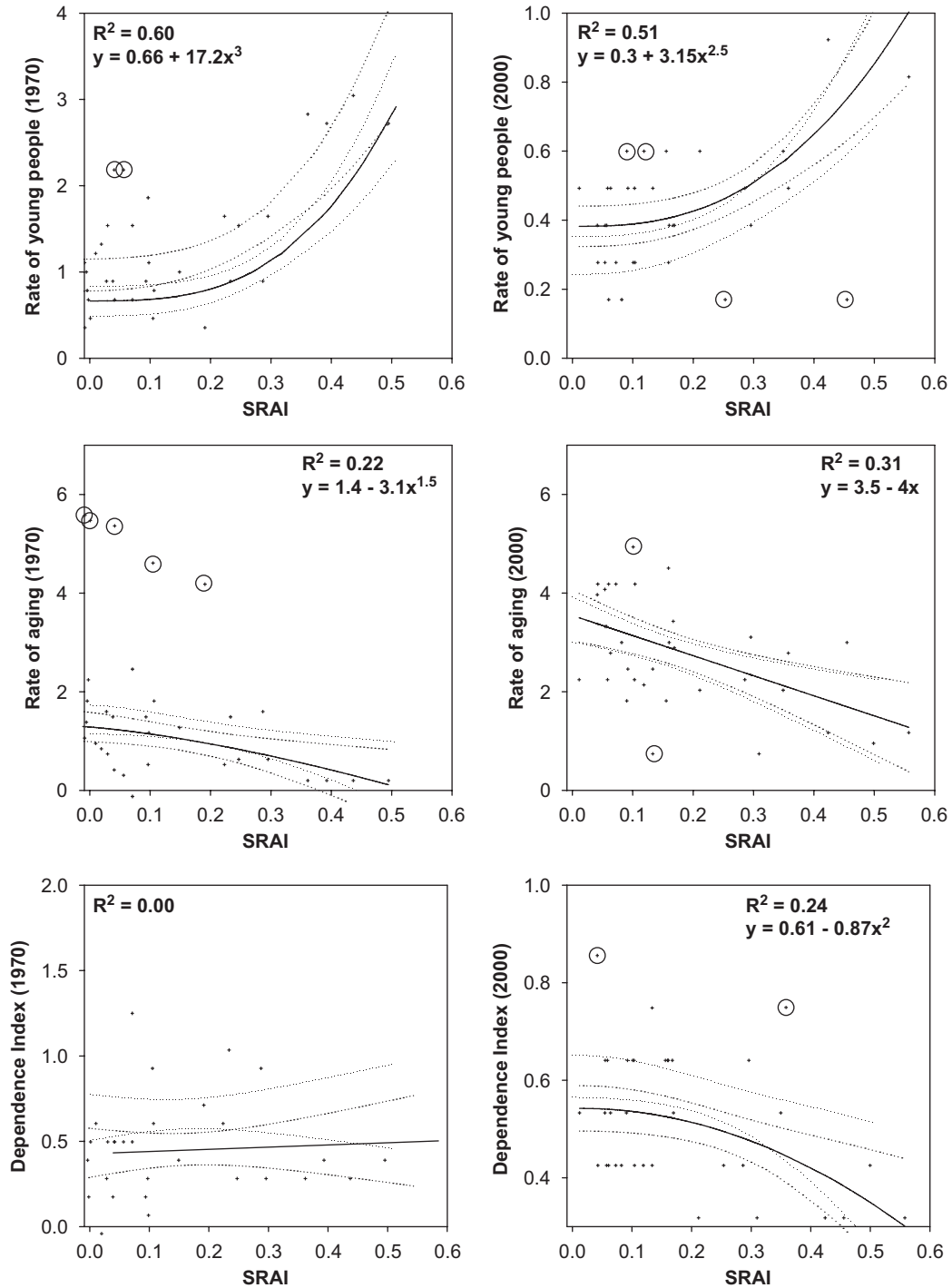


Fig. 6. Relationship between the spatial distribution of the SRAI and the demographic structure in 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

practices, mainly the keeping of livestock, underwent an important decrease (López Palomeque, 1996). The main initiative to achieve this has been to introduce ski resorts (Lasanta & Laguna, 2003), a strategy proven to be effective in central Europe (Ferrero, 1998; Godde et al., 2000).

Given that ski resort development in the region has been ongoing for over 30 years, we asked if this growth has been

spatially homogeneous or has instead favoured some municipalities over others. In this study, it has been shown that positive socioeconomic changes that have occurred in the Spanish Pyrenees during this time have been largely restricted to the few municipalities that contain ski resorts or those relatively close and able to access the ski resort-based infrastructure. In these

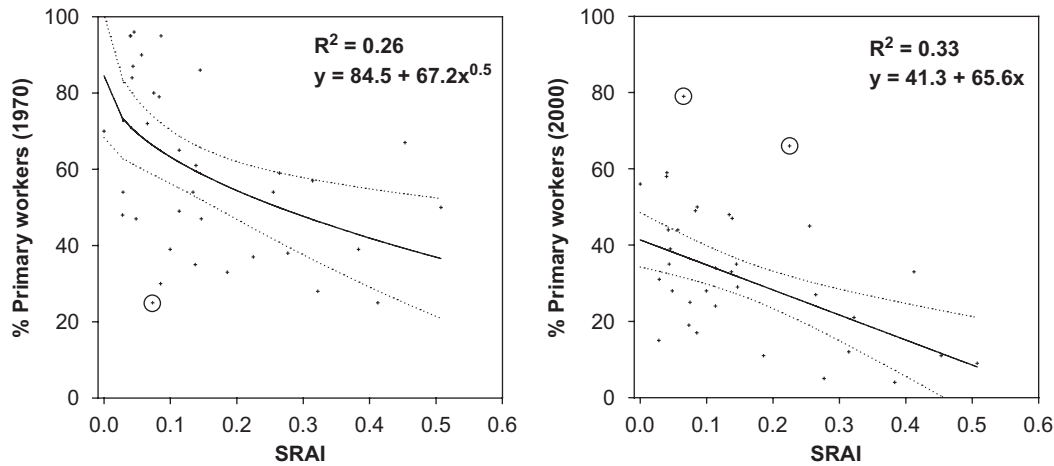


Fig. 7. Relationship between the spatial distribution of the SRAI and the percentage of primary workers in 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

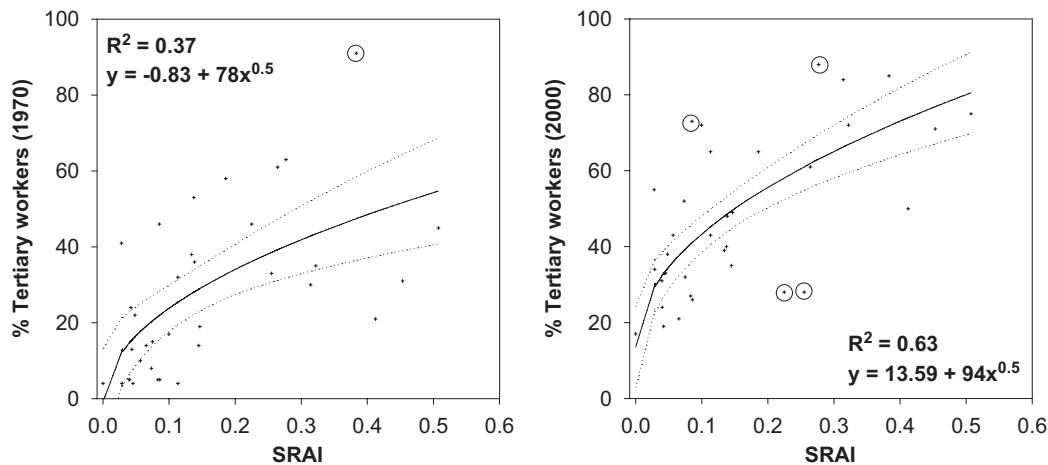


Fig. 8. Relationship between the spatial distribution of the SRAI and the percentage of tertiary workers in 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

municipalities, most populations have remained stable or grown. The population increases are caused by immigrants arriving from surrounding municipalities (Daumas, 1986) and by “neo-rural” people who have developed some kind of tourism-linked business (Loscertales, 1993). The lower dependency rates and aging rates, and the higher rate of young people in these areas can be explained by considering that the majority of immigrants are workers with children. A similar evolution has been observed in other mountainous regions with highly developed tourism enterprises (Buckley, Pickering, & Warnker, 2000; Pechlaner & Tschurtschenthaler, 2003).

In contrast, villages located further from ski resorts suffered population decreases over the same period, which has caused demographic instability (higher aging index and dependency rates, and a lower proportion of youths). This negative evolution highlights the spatial

differences between municipalities with and without ski-resorts.

These changes also highlight disharmony between the municipalities that benefit from ski resorts and those that do not. Those that do benefit from ski resorts employ a large number of people in the tertiary sector while the number of employees in the primary sector continues to diminish.

This shift can be explained by the influx of immigrants, which are mainly skilled in tertiary sector jobs (mainly the building sector). This trend has also been observed in the Alps. Pechlaner and Tschurtschenthaler (2003) point out that the alpine tourist industry is frequently created by the recruitment of personnel from other regions, and many primary sector employees, especially young people, have found work in other sectors (Balcells, 1987). It has also been shown that the sons of livestock farmers often emigrate or move into the tertiary sector. Preau (1984) showed that only 6.3% of young people in the French Alps

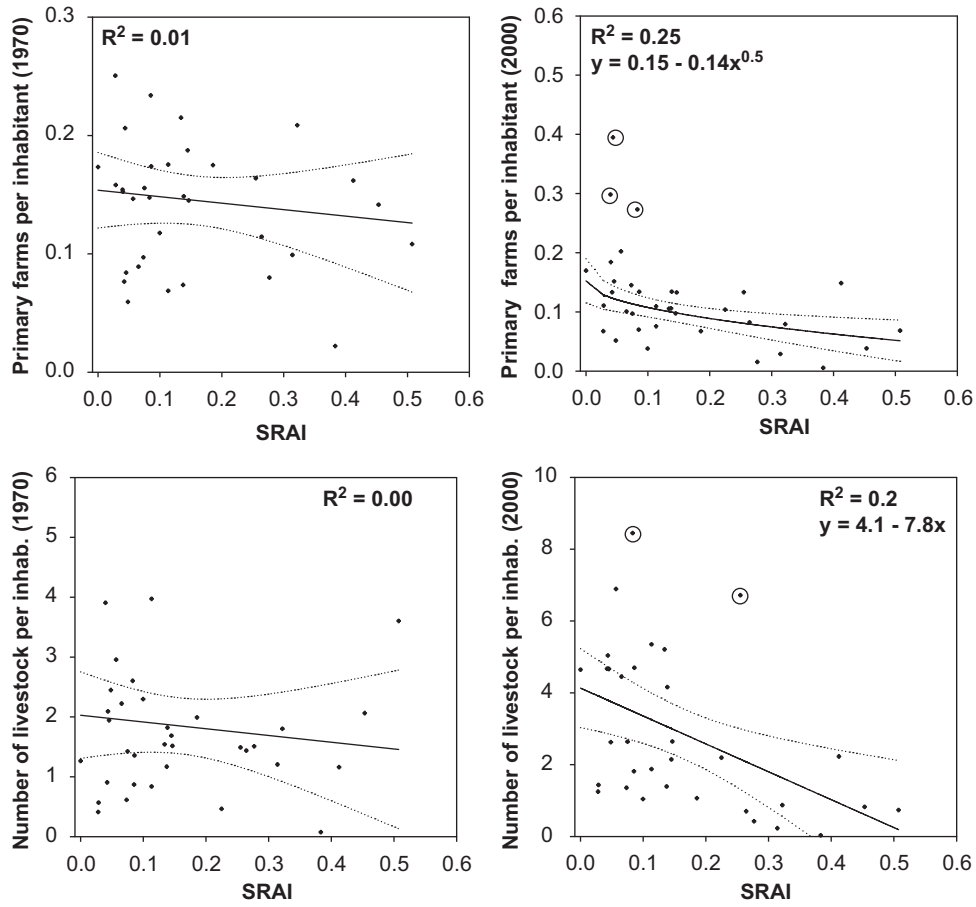


Fig. 9. Relationship between the spatial distribution of the SRAI and the number of primary farms per inhabitant and relationship between the SRAI and the number of livestock per inhabitant in 1970 and 2000. Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

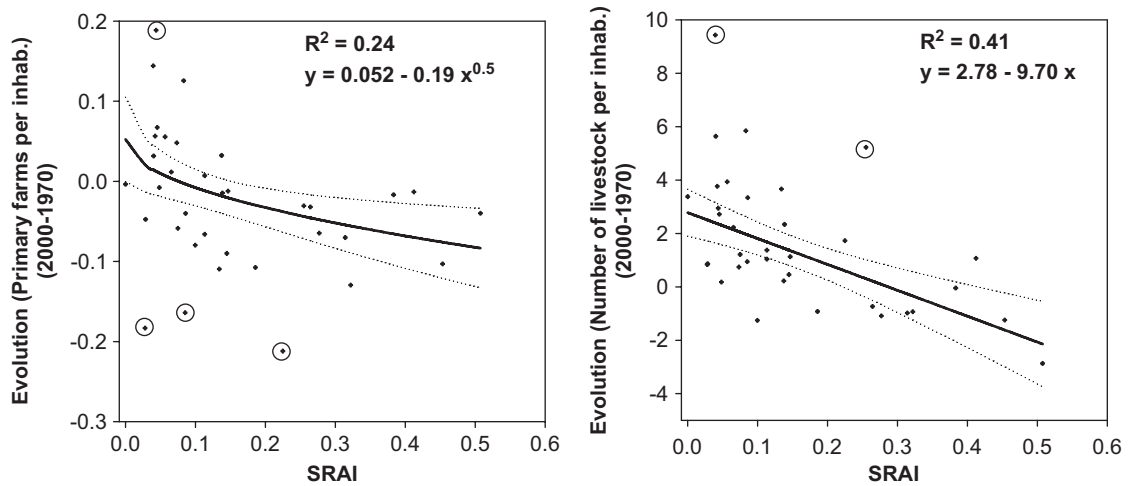


Fig. 10. Relationship between the spatial distribution of the SRAI and the evolution of the number of primary farms per inhabitant and relationship between the number of livestock per inhabitant (1970–2000). Circles indicate the outliers eliminated to calculate the model following a refitting procedure with a confidence level of 90%.

stayed in the primary sector, while 91% moved to tourism-related employment.

Laguna and Lasanta (2003) point out that in Benasque (where the Cerler ski resort is located), only 14%

of farm owners continued to maintain their farms in 2000 from a total of 42 farms that operated in 1965, and 24% of these farms disappeared altogether. Of the farmers that changed jobs during this period, 41% worked

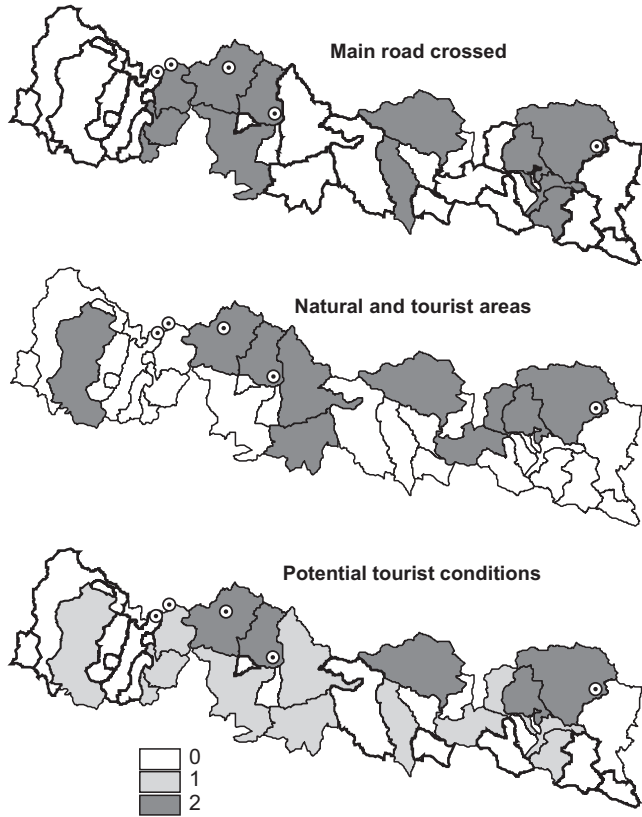


Fig. 11. Spatial distribution of the municipalities that contain wide roads (top), the municipalities that have areas of high natural and landscape interest (middle) and the potential tourist conditions (PTC) (bottom).

in areas related to tourism, and a further 21% had emigrated.

In contrast, villages located further away from ski resorts maintained their primary sector, with around 50% of jobs related to keeping livestock. This difference highlights the changes that have occurred in regions embracing ski resort development.

The evolution of the primary sector also differs between villages. All villages have lost farms following the general trend since the 1950s for rural lands in Spain to become more industrial (Pérez Yruela, 1995; Hoggart & Paniagua, 2001). Nevertheless, those villages related to ski resorts have lost a greater proportion of farms than those not related to ski resorts.

The change in the number of livestock in the Pyrenees has been well documented. The region shows little increase during the study period, from 27,649 head of livestock in 1970 to 31,733 in 2000, and is mainly a result of the increase of farm size required to remain competitive (Manrique, Olaizola, Bernués, Maza, & Sáez, 1999). It is also necessary to consider the positive role of the Common Agricultural Policy, which has facilitated the increase of extensive cattle farming (Laguna, 2004). Nevertheless, the increase has not been homogeneous but rather biased towards municipalities without ski resorts. For example, Benasque lost 33% of its livestock between 1970 and 2000, whereas nine other municipalities located in the same valley increased their livestock by 52%, from 7348 in 1970 to 11,306 in 2000. Laguna and Lasanta (2003) comment on several villages undergoing strong tourism growth. They found that besides transferring the labour force from the primary to the tertiary sector, one village experimented with the transition of meadows (previously used to

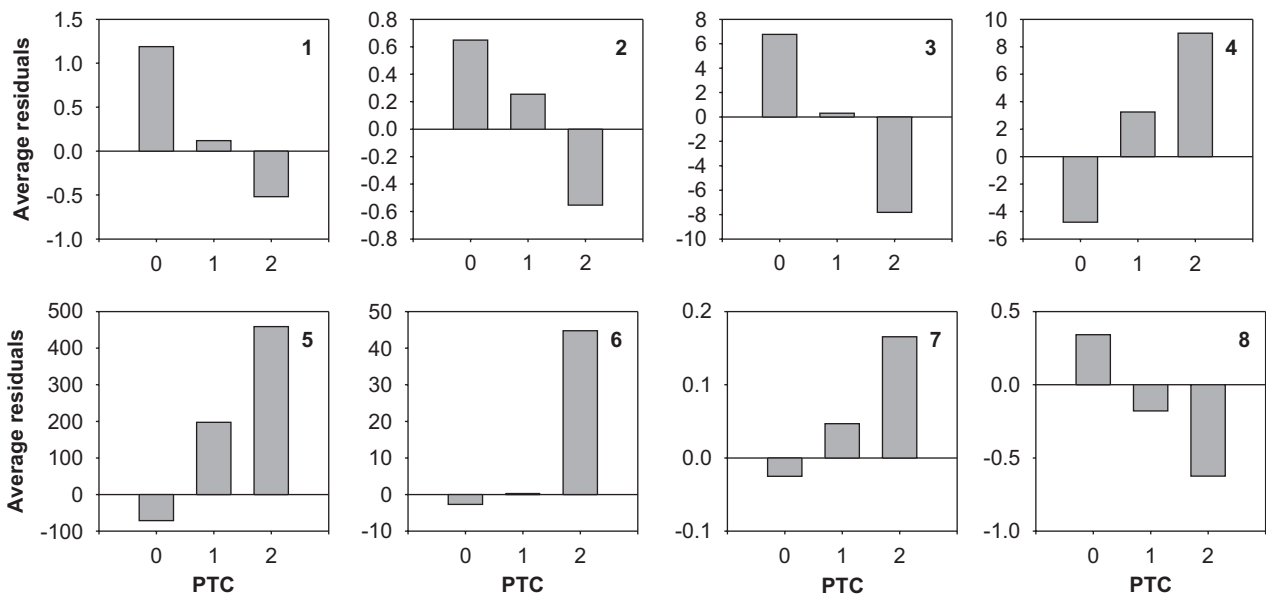


Fig. 12. Average residual values as a function of the PTC for various socioeconomic indicators. (1) Number of livestock per inhabitant (2000), (2) evolution of the number of livestock per inhabitant between 1970 and 2000, (3) percentage of primary workers (2000), (4) percentage of tertiary workers (2000), (5) number of permanent inhabitants (2000), (6) evolution of the number of permanent inhabitants (1970–2000), (7) rate of young people (2000), (8) rate of aging (2000).

maintain farms) to developing tourist infrastructure (urbanisation, sports resorts, roads, etc.). The competition between the tourism and primary sectors is well documented from several other European mountain regions (Oberacher, 1995; Snowdon et al., 2000). In the Pyrenees, the economic development based on the ski resorts seems to follow a growing model by subtraction since the development is concentrated in some municipalities. The rest only contributes with population. For this reason, these municipalities have low possibilities of economical growth since the rate of young people is decreasing and the majority of workers are working in the primary activities. Social services are scarce as a consequence of the high cost and their low competitiveness. The model of evolution also shows the movement of workers from the primary to the tertiary sector, which implies the marginalisation of primary activities and the loss of agricultural and pastoral resources.

This process has caused important negative environmental effects. Several authors have highlighted the necessity to maintain mountain agriculture and livestock in tourism-based development models (e.g., Dax, 2001; Kostopoulou & Kyritsis, 2003; Mühlhous & Wälty, 2001; Wyder, 2001). The landscape conservation in mountain areas can only be ensured by maintaining settlements as well as social and economic activities and by conserving cultural landscapes. In general, this is not possible without maintaining mountain agriculture. If, on the other hand, the tourism industry makes it difficult to maintain extensive livestock lands, one source of income is lost and excessive dependence on tourism results. The decline of livestock numbers from meadows will ultimately yield less profit as land becomes progressively more degraded due to loss of pasture quality, following a well-known process in pastoralist circles (Adler, Raff, & Lauenroff, 2001; Bernués et al., 2005). In the medium term, there is the risk of losing the cheap and widespread fodder resources provided by meadows that allow mountain livestock to be currently competitive in some cases (Lasseur, 2005). Reducing grazing pressure will also facilitate plant succession (substitution of pastures by shrubs), which may have significant effects on the structure and aesthetic quality of the landscape, may lead to an increase in fire hazard, and may impact upon the quality of water supplies to cities and surrounding areas (Beguiria, López-Moreno, Lorente, Seeger, & García-Ruiz, 2003; Lasanta, Vicente-Serrano, & Cuadrat, 2005).

The tourist regions follow different stages following the theory of the Tourism-Area Life Cycle (TALC) (Baum, 1998; Benedetto & Bojanic, 1993; Butler, 1980): Exploration, involvement, development, consolidation, stagnation, and decline/revitalised or rejuvenated. At present, the Spanish Pyrenees are in a stage characterised by large numbers of visitors arriving and also by economic control is passed from local hands to external companies. The most probable evolution will be the decline of the tourism since the present socioeconomic model has very important

limitations for the sustainable development. It is necessary to have a tourism model compatible with the livestock, the use of natural resources and the incorporation of the cultural heritage and the local products to the tourism activities. It would be also needed the support of the civil services and the tourism organisations, and the improvement of the local products, more flexible markets and the increase of the size of the companies (Pechlaner & Tschurtschenthaler, 2003; Weiermaier & Fuchs, 1999).

The results obtained in this study suggest that ski resorts in the Spanish Pyrenees benefit only a restricted area. In municipalities with ski resorts, positive effects are seen in demographic evolution, whereas negative effects are observed in the primary sector. In terms of land management, these changes will have negative consequences in the medium to long term. In municipalities not affected by tourism as a result of ski resort development, there is negative evolution of population size and an increase in livestock farming. This trend favours the maintenance of primary farms and pastoral resources. Both models appear to be unsustainable in the medium term, so it will be necessary to develop new models that allow for the coexistence of tourism and primary activities.

Acknowledgements

This work has been supported by the projects: GGL2005-04863/CLI, CGL2005-04508/BOS financed by the Spanish Commission of Science and Technology (CICYT) and FEDER, PIP098/2005 and PIP176/2005 financed by the Aragón Government, and “Programa de grupos de investigación consolidados” (BOA 48 of 20-04-2005), also financed by the Aragón Government.

References

- Abrudan, I., & Turnock, D. (1998). A rural development strategy for the Apusini Mountains, Romania. *GeoJournal*, 46, 319–336.
- Adler, P., Raff, D., & Lauenroff, W. (2001). The effect of grazing on the spatial heterogeneity of vegetation. *Oecologia*, 128, 465–479.
- André, M. F. (1998). Depopulation, land-use change and landscape transformation in the French Massif Central. *Ambio*, 27, 351–353.
- Balcells, E. (1987). Ordenación en territorios montañosos. In *Estudios sobre la montaña* (pp. 193–248), León.
- Barbier, B. (1993). Problems of the French winter sport resorts. *Tourism Recreation Research*, 18, 5–11.
- Baum, T. (1998). Taking the exit route: extending the tourism area life cycle model. *Current Issues in Tourism*, 1, 167–175.
- Beedie, P., & Hudson, S. (2003). Emergence of mountain-based adventure tourism. *Annals of Tourism Research*, 30, 625–643.
- Beguiria, S., López-Moreno, J. I., Lorente, A., Seeger, M., & García-Ruiz, J. M. (2003). Assessing the effects of climate oscillations and land-use changes on streamflow in the Central Spanish Pyrenees. *Ambio*, 32, 283–286.
- Benedetto, C. A., & Bojanic, D. C. (1993). Tourism Area Life Cycle extensions. *Annals of Tourism Research*, 20, 557–570.
- Bentham, R. (1973). Recreational and environmental planning. *Biological Conservation*, 5, 1–5.
- Bernués, A., Riedel, J. L., Asensio, M. A., Blanco, M., Sanz, A., Revilla, R., et al. (2005). An integrated approach to studying the role of grazing livestock systems in the conservation of rangelands in a protected

- natural park (Sierra de Guara, Spain). *Livestock Production Science*, 96, 75–85.
- Billet, P. (2003). Le contrôle de l'urbanisation dans les zones de montagne. *Bulletin d'Association de Géographes Françaises*, 1, 31–43.
- Brugger, E., Furrer, G., & Messerli, P. (1984). *The transformation of Swiss mountain regions*. Bern: Haupt.
- Buckley, R. C., Pickering, C. M., & Warnker, J. (2000). Environmental management for Alpine tourism and resorts in Australia. In P. M. Godde, M. P. Price & F. M. Zimmermann (Eds.), *Tourism and development in mountain regions* (pp. 27–45). Wallingford: CAB International.
- Butler, R. (1980). The concept of a tourist are cycle evolution. *Canadian Geographer*, 24, 5–12.
- Caravaca, I., & Méndez, R. (1994). Industrial revitalization of the metropolitan areas in Spain. *International Journal of Urban and Regional Research*, 18, 220–232.
- Daumas, M. (1986). La redistribution géographique de la population dans les hautes vallées montagnardes: l'exemple du val de Benasque. *Revue de Géographie Alpine*, 64, 189–196.
- Dax, T. (2001). Endogenous development in Austria's Mountain Regions. *Mountain Research and Development*, 21, 231–235.
- Defert, P. (1967). Le taux de fonction touristique. Mise au point et critique. *Les Cahiers du Tourisme Serie-C*, 5, 110–122.
- Del Barrio, G., Creus, J., & Puigdefàbregas, J. (1990). Termal seasonality of high mountain belts on the Pyrenees. *Mountain Research and Development*, 10, 227–233.
- Ferrer, C. (1988). Los recursos pascícolas del Pirineo Aragonés. *Sociedad Española para el estudio de los pastos*, 28, 25–63.
- Ferrero, G. (1998). Seconde case, politiche urbanistiche e turismo nelle Alpi occidentali italiane. *Revue Géographie Alpine*, 86, 61–68.
- García-Dory, M. A. (1977). Covadonga National Park, Asturias Spain. Its history, conservation interest and management problems. *Biological Conservation*, 11, 79–85.
- García-Ruiz, J. M., & Lasanta, T. (1990). Land-use changes in the Spanish Pyrenees. *Mountain Research and Development*, 10, 267–279.
- García-Ruiz, J. M., & Lasanta, T. (1993). Land use conflicts as a result of land use change in the Central Spanish Pyrenees: A review. *Mountain Research and Development*, 13, 295–304.
- García-Ruiz, J. M., & Sala, M. (1984). Pyrenees and Ebro Basin Complex. In *Geomorphology of Europe* (495pp.). London: Macmillan Reference Books.
- Gill, A., & Williams, P. (1994). Managing growth in mountain tourism communities. *Tourism Management*, 15, 212–220.
- Godde, P. M., Price, M. F., & Zimmermann, F. M. (2000). *Tourism and development in mountain regions*. Oxon: CABI Publishing.
- Haimayer, P. (1989). Glacier-skiing areas in Austria: A socio-political perspective. *Mountain Research and Development*, 9, 51–58.
- Hoggart, K., & Paniagua, A. (2001). The restructuring of rural Spain? *Journal of Rural Studies*, 17, 63–80.
- Hudson, S., & Miller, G. A. (2005). The responsible marketing of tourism: The case of Canadian Mountain Holidays. *Tourism Management*, 26, 133–142.
- Jamal, T., & Getz, D. (1999). Community roundtables for tourism-related conflicts: The dialectics of consensus and process structures. *Journal of Sustainable Tourism*, 7, 290–313.
- Kariel, H. G. (1989). Socio-cultural impacts of tourism in the Austrian Alps. *Mountain Research and Development*, 9, 59–70.
- Knafou, R. (1978). *Les stations intégrées de sports d'hiver des Alpes françaises* (319pp.). Paris: Masson.
- Kostopoulou, S., & Kyritsis, I. (2003). Local people's perceptions of sustainable tourism development in protected mountain areas: The case of Mount Olympus, Greece. *Sustainable World*, 6, 47–58.
- Laguna, M. (2004). *Variabilidad espacial de las políticas de desarrollo rural y de protección ambiental en la gestión del territorio en el Pirineo Aragonés*. Ph.D., Universidad de Zaragoza.
- Laguna, M., & Lasanta, T. (2001). El papel de la Administración en la ampliación espacial de la oferta turística: el caso del Pirineo Aragonés. *X Coloquio de Geografía Rural* (pp. 422–447). Lérida: Asociación de Geógrafos Españoles.
- Laguna, M., & Lasanta, T. (2003). Competing for meadows. A case study on tourism and livestock farming in the Spanish Pyrenees. *Mountain Research and Development*, 23, 169–176.
- Lasanta, T., & Laguna, M., (2003). Desarrollo turístico y sostenibilidad en el Pirineo aragonés: efectos opuestos del modelo dominante. In *Los espacios rurales entre el hoy y el mañana* pp. (58–69) Santander: A.G.E.
- Lasanta, T., Vicente-Serrano, S. M., & Cuadrat, J. M. (2005). Mountain mediterranean landscape evolution caused by de abandonment of tradicional primary activities: A study of the Spanish Central Pyrenees. *Applied Geography*, 25, 47–65.
- Lasseur, J. (2005). Sheep farming systems and nature management of rangeland in French Mediterranean mountain areas. In *Livestock production science: Sheep farming systems*. Avignon: I.N.R.A.
- Lindberg, K., Andersson, T. D., & Dellaert, B. G. C. (2001). Tourism development Assessing social gains and losses. *Annals of Tourism Research*, 28, 1010–1030.
- López Palomeque, F. (1996). Turismo de invierno y estaciones de esquí en el Pirineo catalán. *Investigaciones Geográficas*, 15, 19–39.
- López-Moreno, J. I., & García-Ruiz, J. M. (2004). Influence of snow accumulation and snowmelt on streamflow in the Central Spanish Pyrenees. *Hydrological Sciences Journal*, 49, 787–802.
- Loscertales, B. (1993). *Jacetania. De espacio agrario a espacio turístico* (319pp.). Zaragoza: Prames.
- Manrique, E., Olaizola, A. M., Bernués, A., Maza, M. T., & Sáez, A. (1999). Economic diversity of farming systems and possibilities for structural adjustment in mountain livestock farms. *Options Méditerranéennes B*, 27, 81–94.
- Moser, P., & Moser, W. (1986). Reflections on the Mab-6 obergurgl project and tourism in a Alpine environment. *Mountain Research and Development*, 6, 101–118.
- Mühlinghaus, A., & Wälty, S. (2001). Endogenous development in Swiss Mountain Communities. *Mountain Research and Development*, 21, 236–242.
- Mules, T. (2005). Economic impacts of national park tourism on gateway communities: The case of Kosciusko National Park. *Tourism Economics*, 11, 247–259.
- Needham, M. D., & Rollins, R. B. (2005). Interest group standards for recreation and tourism impacts al ski areas in the summer. *Tourism Management*, 26, 1–13.
- Oberacher, A. (1995). Agriculture and tourism in the Alps. Conflict or symbiosis. *Forderungsdienst*, 43, 109–115.
- Pechlaner, H., & Tschurtschenthaler, P. (2003). Tourism policy, tourism organizations and change management in Alpine regions and destinations: A European perspective. *Current Issues in Tourism*, 6, 508–539.
- Pérez Yruela, M. (1995). Spanish rural society in transition. *Sociologia Ruralis*, 35, 276–296.
- Pignatti, S. (1993). Impact of tourism on the mountain landscape of central Italy. *Landscape and Urban Planning*, 24, 49–53.
- Pomfret, G. (2006). Mountaineering adventure tourists: a conceptual framework for research. *Tourism Management*, 27, 113–119.
- Preau, P. (1984). Le changement social dans une commune touristique de montagne: Saint-Bon-Tarentaise (Savoie). Deuxième article. *Revue Géographie Alpine*, 72, 411–437.
- Price, M. (1987). Tourism and forestry in the Swiss Alps: Parasitism or symbiosis? *Mountain Research and Development*, 7, 1–12.
- Puigdefàbregas, J., & Fillat, F. (1986). Ecological adaptation of traditional land uses in the Spanish Pyrenees. *Mountain Research and Development*, 6, 63–72.
- Schwarzl, S. (1991). Causes and effects of flood catastrophes in the Alps-Examples from summer 1987. *Energy and Buildings*, 16, 1085–1103.
- Smith, J. (1995). *Tourism Analysis. A Handbook*. Longman: Essex.
- Smith, M. D., & Krannich, R. S. (1998). Tourism dependence and resident attitudes. *Annals of Tourism Research*, 25, 783–802.
- Snowdon, P., Slee, B., Farr, H., & Godde, P. M. (2000). The economic impacts of different types of tourism in upland and mountain areas of

- Europa. In P. M. Godde, M. P. Price & F. M. Zimmermann (Eds.), *Tourism and Development in Mountain Regions* (pp. 137–145). Wallingford: CAB International.
- Tooman, L. A. (1997). Applications of the life-cycle model in tourism. *Annals of Tourism Research*, 24, 214–234.
- Walford, N. (2001). Patterns of development in tourist accommodation enterprises on farms in England and Wales. *Applied Geography*, 21, 331–345.
- Weaver, D. B., & Lawton, L. J. (2001). Resident perceptions in the urban-rural fringe. *Annals of Tourism Research*, 28, 439–458.
- Weiermaier, K., & Fuchs, M. (1999). Measuring tourist judgment on service quality. *Annals of Tourism Research*, 26, 1004–1021.
- Wyder, J. (2001). Multifunctionality in the Alps. *Mountain Research and Development*, 21, 327–330.
- Zimmermann, F. (1994). El papel del turismo en la reestructuración de las regiones alpinas. *Papers de Turismo*, 16, 77–87.