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ADAPTATION TO CLIMATE CHANGE IN AUSTRIA (ADAPT.AT)

IDENTIFICATION OF TOURISM TYPES

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1 Aim of the working paper

The working paper at hand constitutes research material that was generated within the project “Adaptation to Climate Change in Austria (ADAPT.AT)" - founded by the Austrian Climate Research Programme (ACRP) - but deserves separate exposition. It aims at identifying and describing different tourism types in Austria by classifying Austria’s NUTS 3 regions according to their tourism characteristics (tourism intensity/dependency, seasonal focus, climate sensitivity, etc.). The resulting classification is supposed to serve as a basis for deriving tourism type specific production function parameters and for estimating tourism type specific climate change impact functions. The paper is structured as follows: chapter 2 starts with an overview of the methods and data used in order to identify different tourism types in Austria. The results of the analysis are presented in chapter 3, whereas chapter 4 comprises some sensitivity analysis.

2 Methods and Data

Besides a brief description of the methods used to classify Austria’s NUTS 3 regions according to their tourism characteristics the following subsections provide an overview of the data available for the subsequent analysis. Graphical illustration of the single variables gives a first notion of the regional segmentation of different tourism types in Austria.

2.1 Methods

As already mentioned, this working paper aims at the identification of groups (tourism types) that share similar tourism characteristics and thus a similar starting base with respect to climate vulnerability, adaptation necessity and adaptation possibilities. For the purpose of classification two multivariate analysis techniques are applied, namely cluster analysis and principal component analysis. Both methods are outlined briefly.

2.1.1 Cluster Analysis

In order to classify all 35 Austrian NUTS 3 regions according to their tourism characteristics the method of cluster analysis is used.[1] Cluster analysis pursues the purpose of organizing information about variables in such a way that relatively homogeneous groups, so called clusters, can be formed. The resulting clusters are supposed to be highly externally heterogeneous and highly internally homogeneous, i.e. members of one cluster should differ as much as possible from members of other clusters while being as akin as possible to members of the same cluster. Classification takes place on the one hand by means of

[1] For a methodological overview see for example Backhaus et al. (2003) or Bortz (2005).

proximity (or distance) measures that quantify the proximity (or distance) between each two objects, and on the other hand by means of a cluster algorithm that aggregates the objects to groups according to their proximity (or distance) values. Within the analysis at hand the squared Euclidian distance[2] is used along with the hierarchical method[3] of "Ward". Compared to other algorithms, Ward's method is said to find very good partitions in the majority of cases and to allocate the objects to the "right" group (see Berg, 1981; cited in Backhaus et al., 2003). It decides on object allocation and opening of new groups by minimizing the variance within the groups and shows a tendency of forming clusters of about the same size. However, some preconditions should be fulfilled when using Ward's algorithm, including uncorrelatedness of the variables used within the cluster analysis as well as the absence of outliers. To identify eventual outliers we make use of the so called "single linkage" or "nearest neighbour" algorithm, whereas unintended unequal weighting of variables due to correlation can be avoided by either excluding correlated variables from the analysis or reducing them to uncorrelated factors by means of principal component analysis (see chapter 2.1.2 for more details on principal component analysis).

In order to decide on the number of clusters we apply the so called elbow criterion. Therefore, the heterogeneity development is plotted against the corresponding number of clusters. If an elbow appears in the heterogeneity development it can be used as decision criterion for the number of clusters to be chosen.

Lastly, to test for the robustness of the cluster solution obtained by Ward's algorithm, further hierarchical methods, including "within-groups linkage", "between-groups linkage", "centroid clustering" and "median clustering", are applied for reasons of comparison.

2.1.2 Principal Component Analysis

The aim of a principal component analysis (PCA) is to reduce data from a large set of correlated variables to a smaller set of uncorrelated underlying factors with a minimum loss of information.[4] Thus, in order to avoid the problem of unequal weighting due to correlated variables within a cluster analysis, PCA can be used to pre-process the original data.

PCA transforms the data to a new coordinate system under the restriction of successive variance maximization and orthogonal rotation transformation. In other words, a PCA generates linear combinations of the original variables, where the weights of these

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[2] $d_{ik} = \sum_{j=1}^{J} (x_{ij} - x_{kj})^2$, where x_{ij} and x_{kj} indicate the value of variable j at objects i and k; (j=1,2,…,J).

[3] Hierarchical clustering methods start with the finest possible partition where every object forms a cluster on its own. Based on the matrix of distances they then steadily combine objects without regrouping until all objects form one cluster. It is the user's task to decide on the best number of clusters.

[4] For a methodological overview see for example Backhaus et al. (2003) or Bortz (2005).

combinations are calculated in such a way that on the one hand an orthogonal rotation transformation is caused (i.e. a rotation of the coordinate system by maintaining the orthogonality of the axes) and on the other hand the new axes explain successively maximal variance (i.e. the greatest variance by any projection of the data comes to lie on the first coordinate, the second greatest variance on the second coordinate, and so forth). The axes generated in the described manner represent the PCA-factors, which are uncorrelated and explain successively maximal variance.

The higher the absolute correlation of the original variables the fewer factors are needed for explaining their total variance. Thus, before running a PCA, the data needs to be analysed according to its adequacy since there has to be some degree of correlation between the variables in order that a PCA makes sense. Criterions for evaluating the data's adequacy amongst others include:

- the anti-image covariance matrix criterion and
- the "Measure of Sampling Adequacy" (MSA) or Kaiser-Meyer-Olkin-criterion.

Both criterions are based on the idea that the variance of a variable can be divided into two parts, namely the so called "image" and "anti-image". The former represents the portion of a variable's variance that can be explained by the remaining variables in the data set by means of multiple regression, whereas the latter describes the portion of the variable's variance that is independent of the remaining variables in the data set. Since PCA assumes the variables in the data set to share common underlying factors, data adequacy requires the variables' anti-images to be as small as possible. Thus, in order to qualify for PCA the anti-image covariance matrix criterion requires the proportion of off-diagonal elements in the anti-image covariance matrix with a value higher than 0.09 not to exceed 25% (see Dziuban and Shirky, 1974; cited in Backhaus, 2003).

The second criterion mentioned above is considered to be the best available method for testing the adequacy of the correlation matrix for PCA. The MSA-criterion is calculated on the basis of the anti-image correlation matrix and indicates the extent to which the base variables belong together. Besides the evaluation of the correlation matrix as a whole it also allows to evaluate the single variables. The measure of sampling adequacy takes on values between 0 and 1, where a value smaller than 0.5 indicates that the correlation matrix does not qualify for PCA (see Kaiser and Rice, 1974; cited in Backhaus et al., 2003).

To decide on the number of extracted factors, we make use of the "Kaiser-criterion", which recommends extracting all those factors whose eigenvalues are greater than 1. Eigenvalues are calculated as sum of squared loads of a factor over all variables. They represent a benchmark for the variance of the observed values which is explained through the respective factor.

2.2 Data

The subsequent sections deal with the data used for classifying Austria's NUTS 3 regions according to their tourism characteristics. Besides describing and illustrating the single variables, the data's adequacy for PCA is tested as well.

2.2.1 Potential indices for cluster analysis

Table 2-1 gives an overview of the variables available for cluster analysis. All data is given at NUTS 3 level. The two main sources of the economic data are the ISIS database and the Structural Business Statistics, both provided by Statistics Austria. At the time of investigation, data from the ISIS database was available until 2009, whereas data from the Structural Business Statistics was available only until 2007. Thus, for the purpose of consistency, averages for indices including economic variables were calculated for the years 2003 to 2007. Meteorological data is provided by the "Zentralanstalt für Meteorologie und Geodynamik" (ZAMG), whereas data on the transport capacity in ski resorts is taken from JOANNEUM RESEARCH (2008).

Table 2-1: Overview of potential indices for cluster analysis

Abbreviation	Explanation	Data source
NightsWi Ø 2003-2007	Percentage share of winter overnight stays in total overnight stays. Represents an indicator for seasonal focus.	ISIS database (Statistics Austria)
BedsWi Ø 2003-2007	Number of beds available during the winter season in terms of number of beds available during the summer season. Represents an indicator for seasonal focus.	Structural Business Statistics (Statistics Austria)
TourDens Ø 2003-2007	Tourism density measured as overnight stays per inhabitant and year. Represents an indicator for the intensity of touristic utilization and the general importance of overnight tourism.	ISIS database (Statistics Austria)
ConcTour Ø 2003-2007	Concentration of employment in the tourism sector measured as share of tourism employees[a] in total employees at NUTS 3 level compared to the corresponding share at the national level. Represents an indicator for the dependency of the regional labour market on tourism.	Structural Business Statistics (Statistics Austria)
TCperEmpl Ø 2003-2007	Aggregated transport capacity[b] of those ski resorts within a NUTS 3 region that pass the chosen size constraint[c] divided by the number of tourism employees. Represents an indicator for the alpine skiing focus or the importance of snow as a factor of production, and thus for vulnerability.	JOANNEUM RESEARCH (2008) Structural Business Statistics (Statistics Austria)
SnowDepth Ø 1973-2006	Average snow depth in the ski resorts of a NUTS 3 region. The indicator is calculated as a weighted average of the mean snow depth during the winter season at the representative mean altitudes of those ski resorts within a NUTS 3 region that pass the chosen size constrained. Transport capacity serves as weighting factor. Represents an indicator for the snow situation in the ski resorts of a NUTS 3 region under the present climatic conditions.	JOANNEUM RESEARCH (2008) ZAMG
z_max	Weighted average of the highest point of settlement (measured in meters above sea level) of each community within a NUTS 3 region. Community area serves as weighting factor. Represents an indicator that allows drawing conclusions about the feasible types of touristic utilization.	ISIS database (Statistics Austria)

Table 2-1 continuation: Overview of potential indices for cluster analysis

Abbreviation	Explanation	Data source
HighQualWi Ø 2003-2007	Percentage share of high quality beds (4/5-stars category) in total beds (hotels and similar establishments) during the winter season. Represents an indicator for vulnerability.	ISIS database (Statistics Austria)
HighQualSu Ø 2003-2007	Percentage share of high quality beds (4/5-stars category) in total beds (hotels and similar establishments) during the summer season. Represents an index for vulnerability.	ISIS database (Statistics Austria)

[a] The term "tourism employees" encompasses employees in the NACE-sector "Hotels and Restaurants" (NACE-code H, ÖNACE 2003).

[b] The transport capacity is measured in "person altitude meters per hour", which indicates the maximum number of persons, who can be transported within one hour, multiplied by the altitude difference of the respective transport facilities. We assume that the data, which is only available for the winter season 2001/2002, is representative for the average between 2002 and 2007.

[c] Only ski resorts with more than five transport facilities or at least one cable car are considered in the analysis.

What follows is a more detailed description of the indices listed in Table 2-1 and their manifestation in Austria's NUTS 3 regions in order to get a first notion of the regional tourism characteristics.

Indicator(s) for season focus

The percentage share of winter overnight stays in total overnight stays (NightsWi) and the number of beds available during the winter season in terms of the number of beds available during the summer season (BedsWi) both represent indicators for the relative importance of winter or summer tourism in the respective NUTS 3 region. However, whereas the former variable shows seasonal differences on the demand side, the latter indicates seasonal differences on the supply side.

As Figure 2-1 and Figure 2-2 show, NUTS 3 regions with a clear or slight focus on winter tourism in terms of overnight stays and available beds are concentrated in the western part of Austria along the main chain of the Alps. Lungau shows the clearest winter focus in terms of both indices, whereas Nordburgenland (in terms of overnight stays) and Unterkärnten (in terms of available beds) represent the regions with the clearest summer focus.

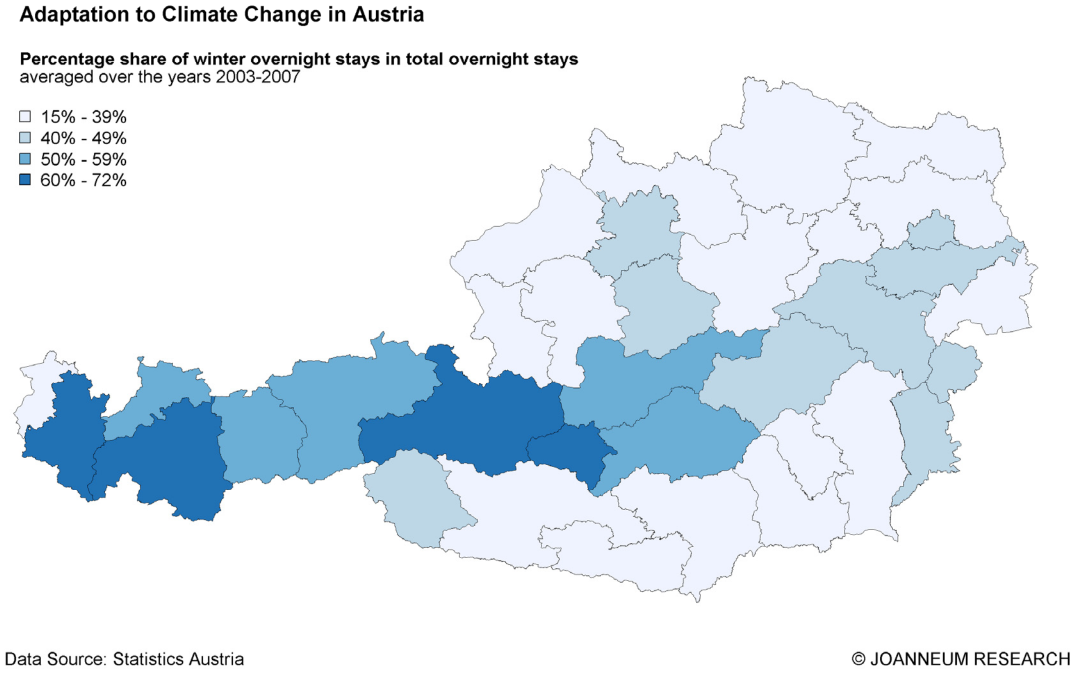

Figure 2-1: Average share of winter overnight stays in total overnight stays, 2003-2007

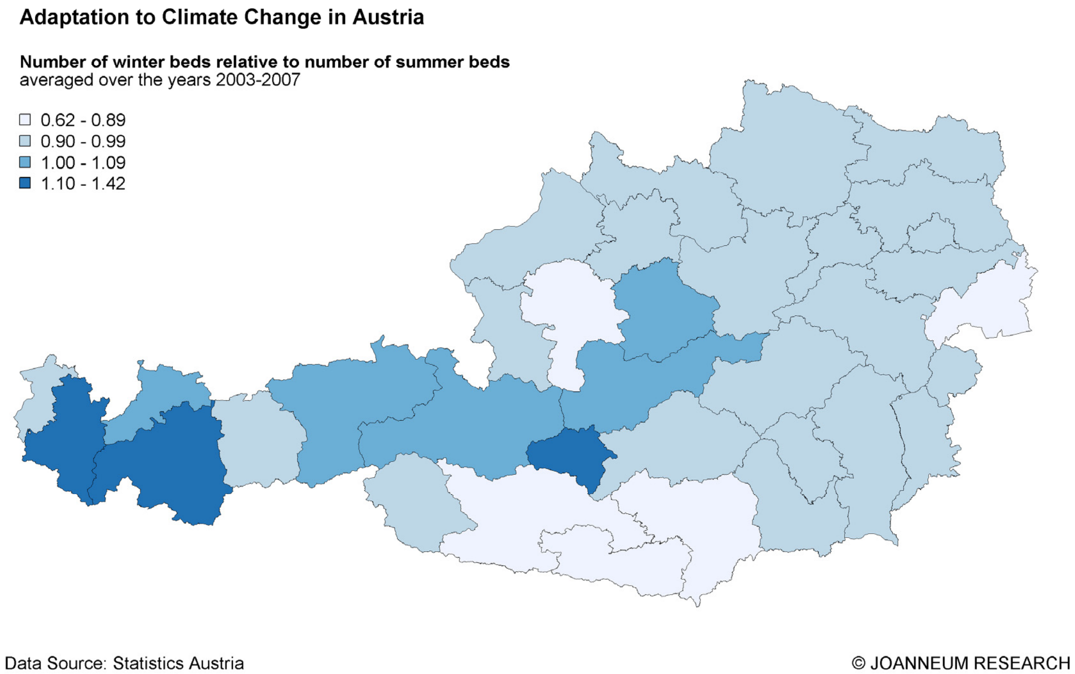

Figure 2-2: Average proportion of winter beds to summer beds, 2003-2007

Indicator(s) for tourism importance/dependency

Tourism density (TourDens) is supposed to indicate the intensity of touristic utilization and the general importance of overnight tourism for the respective NUTS 3 region. As shown in Figure 2-3 the most tourist intense regions in terms of overnight stays per inhabitant and year are located in the western part of Austria. With an average of 122 overnight stays per inhabitant and year between 2003 and 2007 Tiroler Oberland represents the region with the highest tourism density in Austria. In contrast, the region with the lowest tourism density, Weinviertel, counts 1.3 overnight stays per inhabitant and year. By way of comparison, Austria as a whole reports an average tourism density of 14 during the period under consideration.

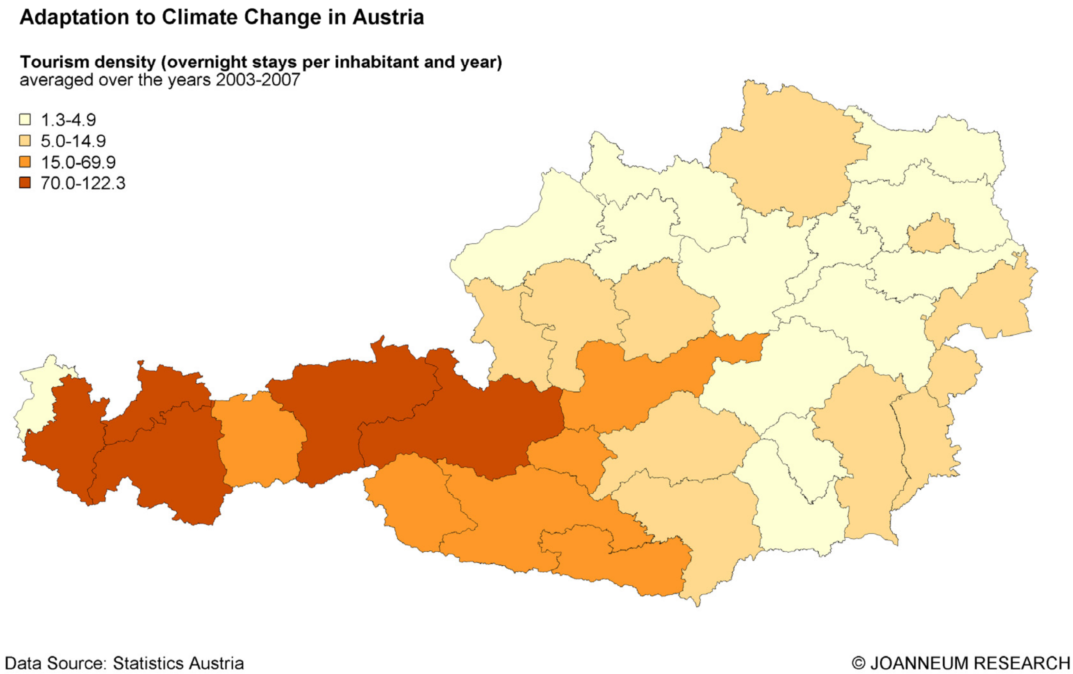

Figure 2-3: Average tourism density (overnight stays per inhabitant and year), 2003-2007

The concentration of employment in a region's tourism sector by comparison to the Austrian average (ConcTour) gives something in evidence about the importance of the tourism sector as employer and thus about the dependency of the regional labour market on tourism. The index is calculated according to the following formula:

$$ConcTour = \left(\frac{EmplTour(NUTS3) / EmplTot(NUTS3)}{EmplTour(Austria) / EmplTot(Austria)} \right)$$

where EmplTour indicates the number of employees in the tourism sector and EmplTot denotes total employees. Thus, a value of one indicates that the concentration of employment in the tourism sector equals the Austrian average. As illustrated in Figure 2-4, regions that show an above national average concentration of employment in the tourism sector are mainly concentrated in the western and southern part of Austria with a few exceptions located in the northern and western part of the country. The highest concentration of employment in the tourism sector is found in Tiroler Oberland, whereas Linz-Wels shows the lowest concentration.

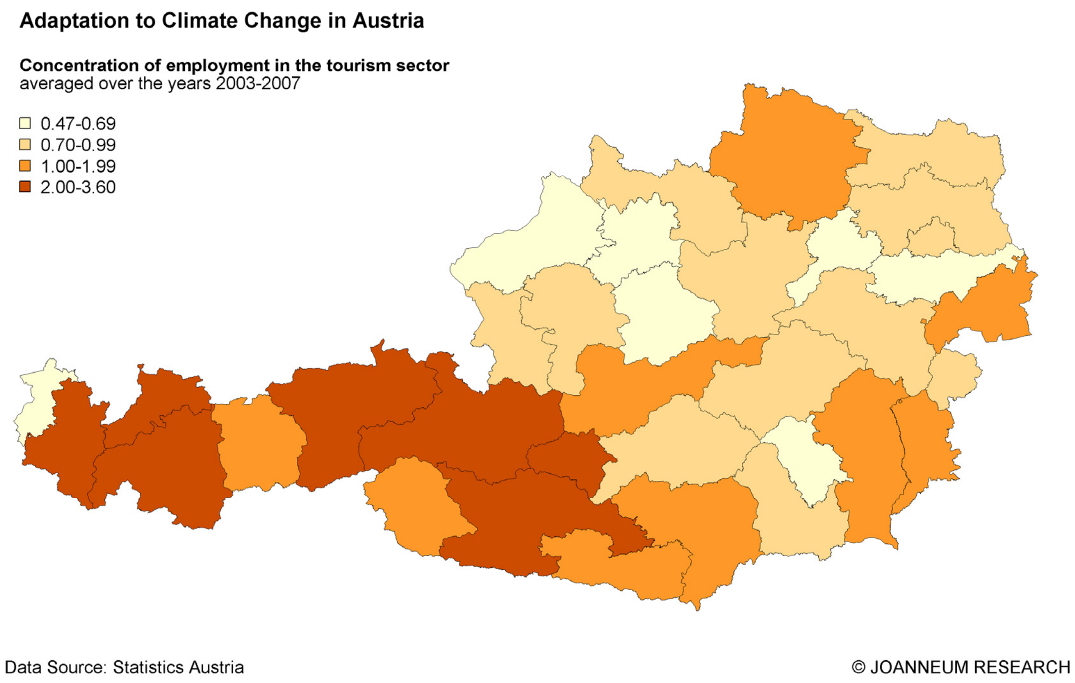

Figure 2-4: Average concentration of employment in the tourism sector, 2003-2007

Indicator(s) for snow importance/dependency

The aggregated transport capacity per tourism employee (TCperEmpl) is supposed to serve as a proxy for the alpine skiing focus of a region's tourism industry and the importance of snow as a production factor, respectively. An index of zero indicates that there are no ski resorts located in the respective NUTS 3 region that pass the chosen size constraint. Thus, snow is of no or hardly any importance for the tourism industry in those regions. In contrast, high (low) values point to a high (low) extent of installed transport capacity relative to the number of employees in the tourism sector and thus to a high (low) importance of snow for the tourism sector of the respective region. Thus, the considered index gives something in evidence about the exposure of the region's tourism industry towards snow availability. As shown in Figure 2-5, regions with high aggregated transport capacities per tourism employee are located alongside the main chain of the Alps. In contrast, those regions for which snow is of hardly any importance for the regional tourism industry are mainly found in Lower Austria and Burgenland.

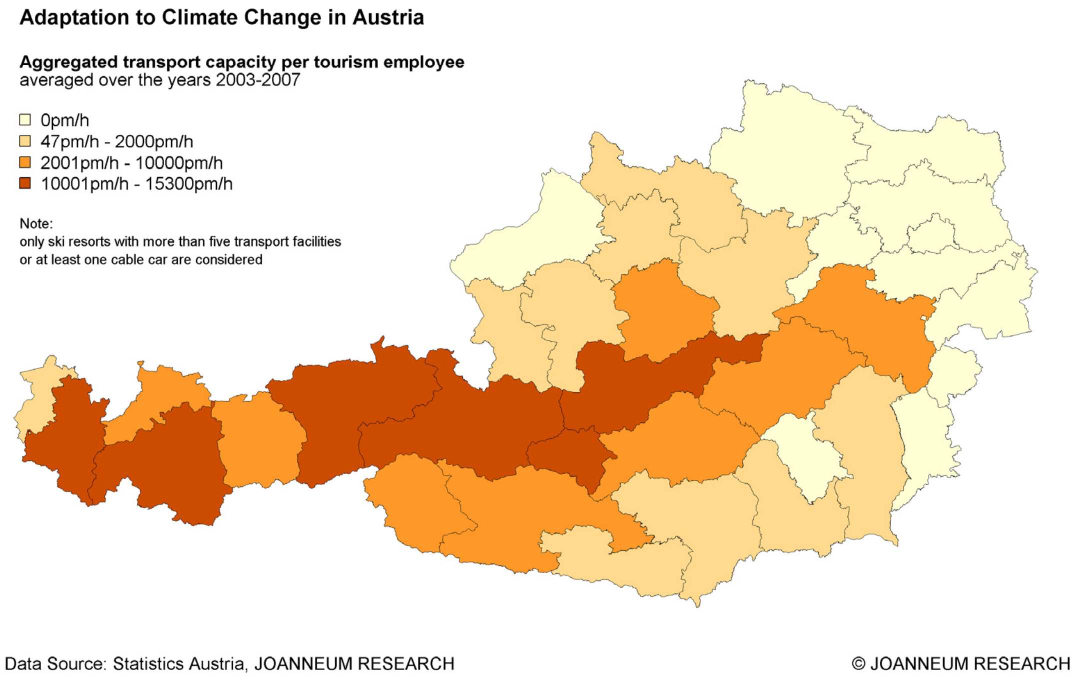

Figure 2-5: Average of the aggregated transport capacity per tourism employee, 2003-2007

Indicator(s) for past/current snow situation

The average snow depth (SnowDepth) and the average number of snow days (SnowDays) per winter season both represent indices for the snow situation in the average ski resort of a NUTS 3 region under the past and present climatic conditions[5]. In terms of average snow depth, the ski resorts in the NUTS 3 regions Bludenz-Bregenzer Wald, Tiroler Oberland, Oberkärnten, Traunviertel, Liezen and Mostviertel-Eisenwurzen show the most favourable snow situations under current climatic conditions (see Figure 2-6). Regarding the average number of days with at least 1 cm snow depth, the ski resorts in Bludenz-Bregenzer Wald, Tiroler Oberland, Oberkärnten, Lungau, Pinzgau-Pongau and Traunviertel turn out to be the most favoured[6] (see Figure 2-7).

[5] Again, only ski resorts passing the chosen size constraint are considered.

[6] In Pinzgau-Pongau there are 22 ski resorts that pass the chosen size constraint. Bludenz-Bregenzer Wald and Tiroler Oberland each encompass 18 such ski resorts, Oberkärnten 15, Liezen 11, Traunviertel 6, and Lungau as well as Mostviertel-Eisenwurzen 4.

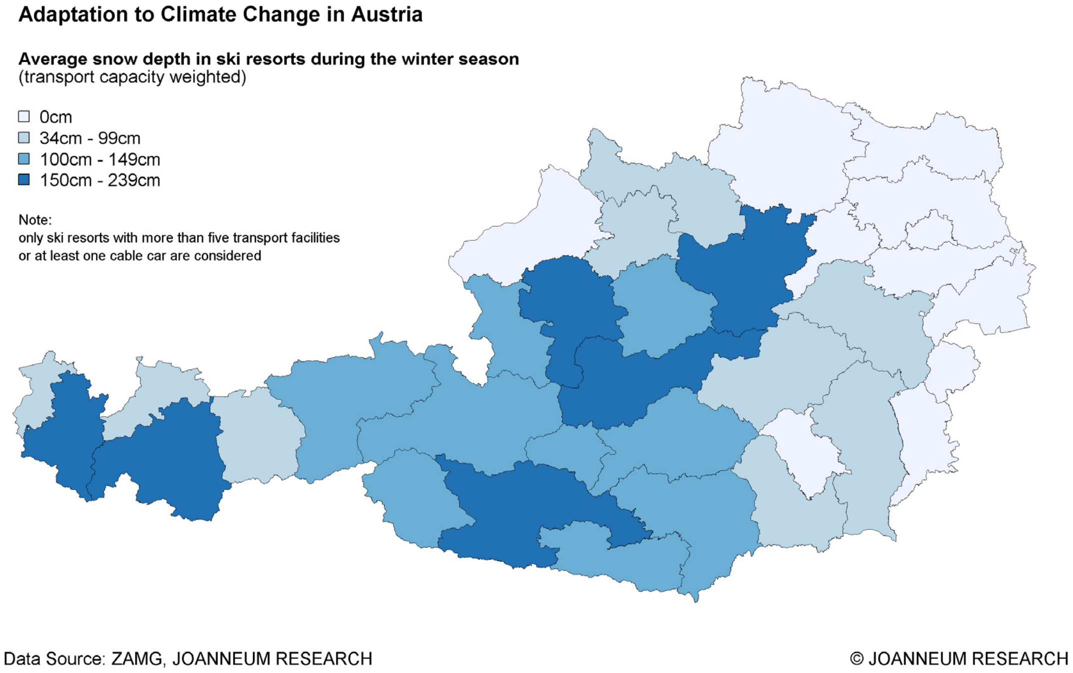

Figure 2-6: Transport capacity weighted average snow depth in the ski resorts of each NUTS 3 region during the winter season, 1973-2006

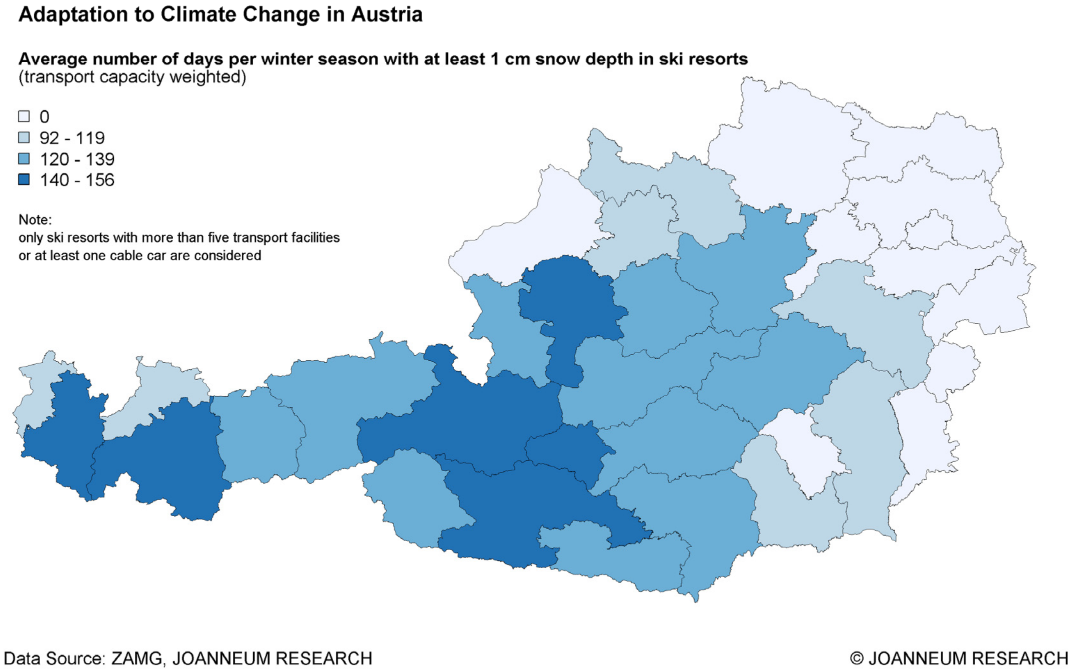

Figure 2-7: Transport capacity weighted average number of days with at least 1 cm snow depth in the ski resorts of each NUTS 3 region during the winter season, 1973-2006

Indicator(s) for feasible types of touristic utilization

Since some meteorological parameters such as snowfall and temperature depend on the sea level, the aggregation of Austria's NUTS 3 regions to groups with similar sea levels represents an aspect of the different initial conditions for tourism activities. In other words, the height above sea level allows drawing conclusions about the feasible types of touristic utilization. Therefore, Figure 2-8 shows a classification of Austria's NUTS 3 regions according to the weighted averages of the highest points of settlement of their communities (z_max).

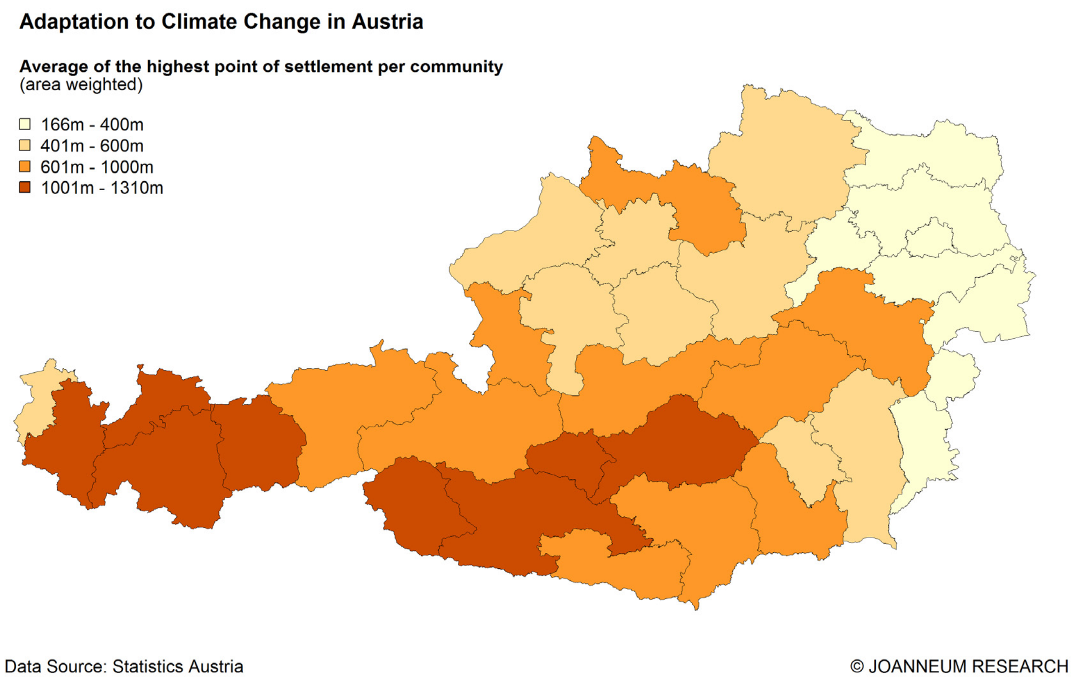

Figure 2-8: Area weighted average of the highest point of settlement of the communities within each NUTS 3 region

Indicator(s) for climate vulnerability

The percentage share of high quality winter beds (4/5-star category) in total winter beds and the percentage share of high quality summer beds in total summer beds both represent some sort of vulnerability indicators, since regions with a low share of high quality beds are supposed to be more vulnerable to weather variability and climate change as people most probably choose such destinations mainly due to its scenery. As shown in Figure 2-9 and Figure 2-10 the NUTS 3 regions with the highest shares in high quality beds are Wien, Wiener Umland/Süd, Süd- and Mittelburgenland as well as Salzburg. In contrast, the lowest share in high quality beds is found in Östliche Obersteiermark. The highest difference between winter and summer season, both in absolute and relative terms, is recorded in

Lungau, where the share of high quality beds in total beds on average accounts for 30% during the winter season and 22% during the summer season.

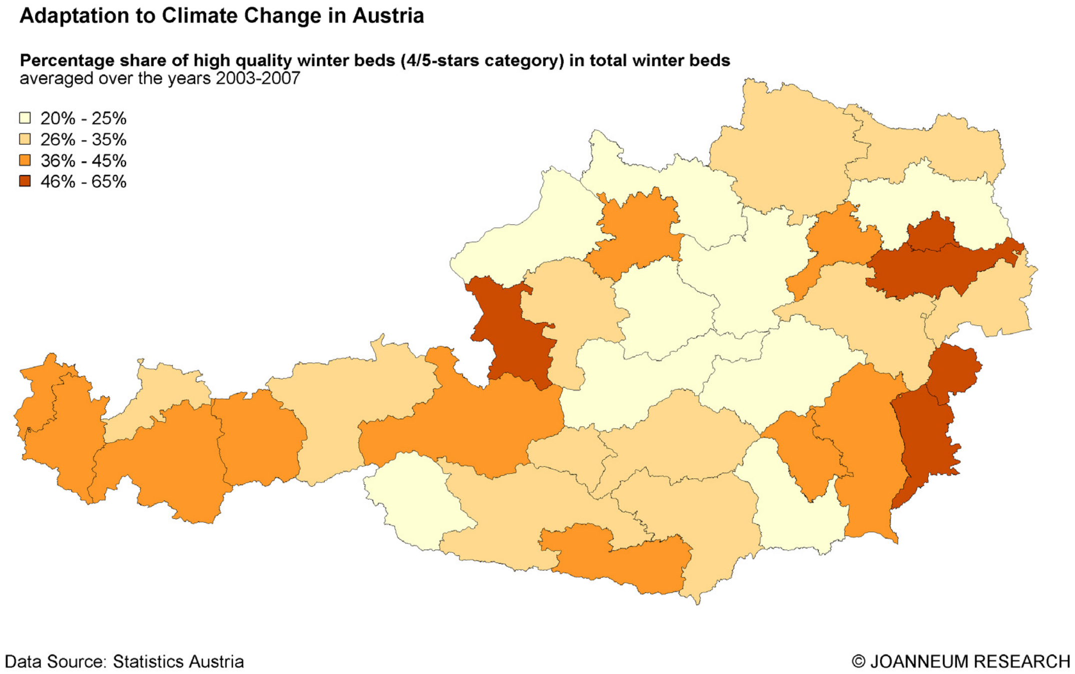

Figure 2-9: Percentage share of high quality winter beds (4/5-stars category) in total winter beds, 2003-2007

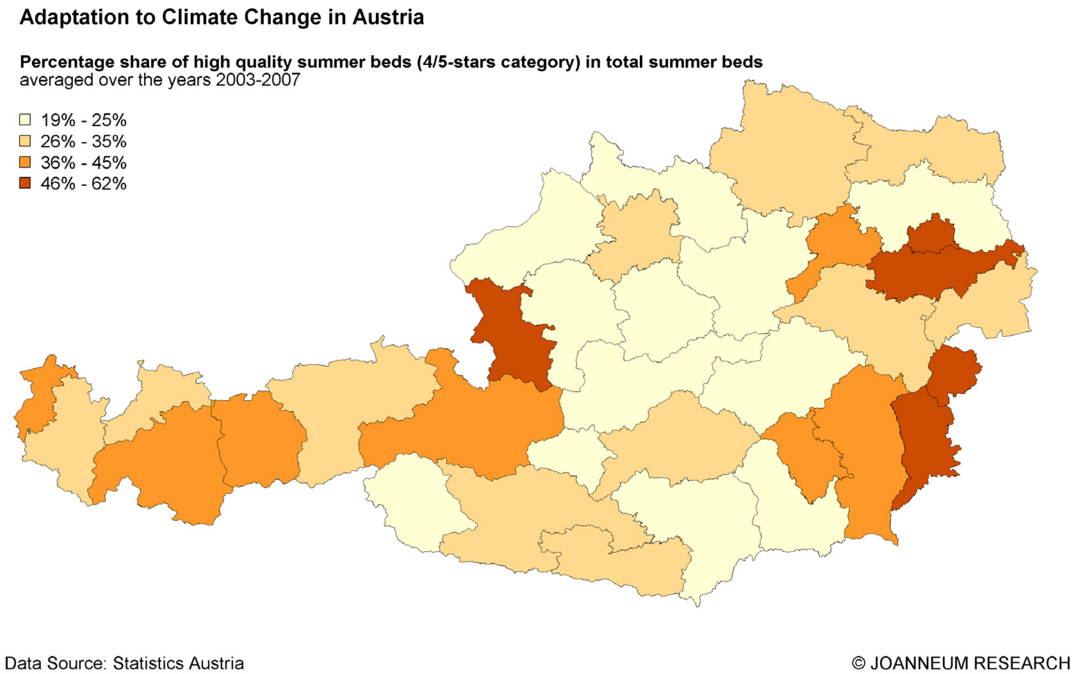

Figure 2-10: Percentage share of high quality summer beds (4/5-stars category) in total summer beds, 2003-2007

As mentioned in chapter 2.1.1, applying Ward's algorithm within cluster analysis requires the entering variables to be uncorrelated. Thus, in case of using the original values of the variables described above, a selection has to be drawn since variables approximating the same indicator can be expected to be highly correlated. However, as shown in Table 6-1 in the appendix, there is not only high correlation between variables of the same index category, but partly also between variables of different ones. An alternative to excluding correlated variables from the analysis is reducing the data set to uncorrelated factors by means of PCA. Therefore, we test our data set for its PCA adequacy.

2.2.2 Suitability of the data for PCA

An important point before running a PCA is to test the data for its suitability. As mentioned in chapter 2.1.2 two criteria are applied within the analysis at hand to analyse the data according to its PCA adequacy: the anti-image covariance matrix criterion and the MSA- or Kaiser-Meyer-Olkin-criterion.

As shown in Table 6-2 in the appendix, the data set passes the anti-image covariance matrix criterion since the proportion of off-diagonal elements with a value greater than 0.09 only amounts to 4.44%, which is clearly below the threshold of 25%. The Kaiser-Meyer-Olkin-criterion, that requires the "measure of sampling adequacy" for the set of all variables and each individual variable to exceed the value of 0.5, is fulfilled as well. The MSA values of the individual variables, presented in Table 6-3 in the appendix, range from 0.523 to 0.877, whereas the MSA of all variables together amounts to 0.733. Since the data set at hand qualifies for running a PCA, the problem of unintended unequal weighting is addressed by pre-processing the original data set by means of PCA and using the resulting factors for the cluster analysis. Both, PCA outcomes and cluster analysis results are presented in the subsequent chapter.

3 Results

3.1 Principal Component Analysis

Running a PCA with the data set described in chapter 2.2.1 and using the "Kaiser-criterion" to decide on the number of factors leads to the extraction of three factors, which together explain 89% of the total variance of all variables in the data set (see Table 6-4 in the appendix). As shown in Table 6-5 in the appendix the first factor is characterized by high loadings of the indicators for tourism importance/dependency, snow importance/dependency, past and current snow conditions and feasible types of touristic utilization. The second factor shows high loadings of the indicators for seasonal focus, tourism importance/dependency and snow importance/dependency, where the latter two however load higher on the first than on the second factor. And last but not least, the third factor is characterized by high loadings of the variables measuring the share in high quality beds.

3.2 Cluster Analysis

The three factors resulting from the PCA are used to run a hierarchical cluster analysis that applies Ward's method along with the squared Euclidian distance. As mentioned in chapter 2.1.1, besides uncorrelated variables the absence of outliers should be ensured when using Ward's algorithm. However, in the case at hand Ward's method leads to the same cluster solution regardless of whether removing the three outliers indicated by the nearest neighbour algorithm (Lungau, Oberkärnten, and Wien) or not. The cluster solution is illustrated in Figure 3-1, where the elbow criterion was used in order to decide on the number of clusters (see Figure 6-1 in the appendix).

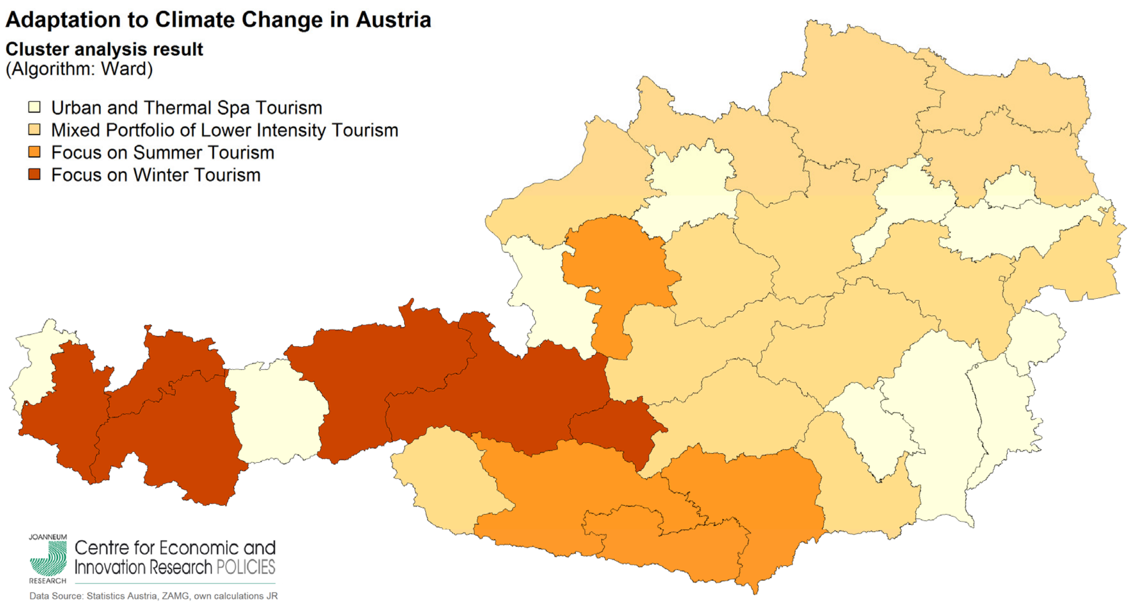

Figure 3-1: Cluster analysis result

Table 3-1 summarizes the group means of the variables together with the corresponding standard deviation, which serves as a measure for the variation within the groups. A more detailed description of each cluster type follows below.

Table 3-1: Means and standard deviations within the four clusters

Variable	Coefficient	Urban (1)	Mixed (2)	Focus Summer (3)	Focus Winter (4)	All Regions
NightsWi	mean	40.22	37.09	24.29	62.30	40.93
	sd	4.61	10.79	8.64	8.51	13.69
BedsWi	mean	0.96	0.98	0.75	1.13	0.97
	sd	0.03	0.03	0.15	0.15	0.13
TourDen	mean	7.57	9.95	22.58	89.90	24.35
	sd	6.37	13.34	19.42	22.05	33.46
ConcTour	mean	0.85	0.98	1.31	2.68	1.27
	sd	0.25	0.37	0.58	0.52	0.76
TCperEmpl	mean	559.01	2798.10	3147.33	13071.88	3895.52
	sd	1141.91	3645.65	3357.09	2500.06	5138.29
SnowDepth	mean	38.16	68.54	175.56	154.12	85.89
	sd	50.67	66.73	67.81	53.01	76.84
SnowDays	mean	52.52	77.21	139.51	139.47	87.24
	sd	61.20	61.04	10.80	13.39	61.62
z_max	mean	493.13	623.58	743.81	1097.31	677.54
	sd	238.71	312.96	189.64	147.41	323.09
HighQualWi	mean	0.46	0.25	0.32	0.36	0.34
	sd	0.08	0.04	0.06	0.04	0.11
HighQualSu	mean	0.45	0.24	0.27	0.33	0.32
	sd	0.08	0.04	0.04	0.06	0.10

Urban and thermal spa tourism (11 regions):

The *urban and thermal spa tourism* cluster includes nearly all NUTS 3 regions with federal capitals – the only exceptions are Klagenfurt-Villach and Nordburgenland - as well as important thermal spa regions (Oststeiermark, Mittel- and Südburgenland and Wiener Umland/Süd). The cluster encompasses regions with all year tourism and regions with some summer tendencies in terms of overnight stays and available beds. Tourism density is predominantly low and except for Südburgenland, Oststeiermark and Innsbruck the concentration of employment in the tourism sector lies clearly below the nationwide concentration (i.e. ConcTour is clearly smaller than one). For half of the NUTS 3 regions within the urban and thermal spa tourism cluster snow has almost no importance as they do not contain any ski resorts that pass the chosen size constraint. Regarding the other half, snow importance lies below the average of those regions that contain ski resorts passing the chosen size constraint. With the exceptions of Salzburg and Innsbruck, the same holds true for the two snow situation indices. The area weighted highest settling points are below the all regions' average of 678 m, except for Innsbruck. In addition, the urban and thermal spa cluster is characterized by the highest share of beds belonging to the 4/5 star category.

Mixed portfolio of lower intensity tourism (14 regions):

With 14 NUTS 3 regions the *mixed portfolio of lower intensity tourism* represents the biggest of the four clusters. The seasonal focus of the regions within the cluster ranges from clear summer to slight winter tendencies. Except for Liezen and Osttirol, which show a tourism density above the all regions' average of 24, overnight stays per inhabitant and year are very low. A similar picture arises with regard to the concentration of employment in the tourism sector, which predominantly lies below the national concentration. The exceptions are again Liezen and Osttirol, which show a concentration that is noticeably above the national average, but still clearly below the concentration of those regions within the winter cluster. There is a great mix with respect to the values of the indicators for the past and current snow conditions since the regions within the cluster range from containing no ski resorts passing the chosen size constraint to comprising ski resorts that on average show similar snow conditions as those of the winter cluster. The same holds true for the importance of snow as a production factor and for the height above sea level. Last but not least, the cluster is characterized by the lowest shares of beds belonging to the 4/5 star category.[7]

Focus on summer tourism (4 regions):

The NUTS 3 regions of the third cluster show a clear focus on summer tourism with respect to overnight stays and available beds. With the exception of Oberkärnten, tourism density lies below the all region's average, whereas except for Traunviertel the concentration of employment in the tourism sector lies above the national concentration. The snow situation in the ski resorts is comparable to the *focus on winter tourism* cluster. However, the importance of snow is found to be clearly lower than in the regions of the *focus on winter tourism* cluster. The average of the highest point of settlement per community ranges from 565 m to 1003 m and the proportion of high quality winter beds more or less equals the all regions' average of 34%. However, during the summer season, the share of high quality beds is somewhat below the all region's average.

[7] Deciding on five instead of four clusters would lead the mixed portfolio of lower intensity tourism cluster to be divided into regions that contain no ski resorts that pass the chosen size constraint, with the exception of Niederösterreich-Süd, and regions that contain such ski resorts. However, the decrease in heterogeneity (within the clusters) caused by this further division is rather small compared to the heterogeneity fall following the transition from the three to the four cluster solution (see Figure 6-1 in the appendix). In addition, differences between the clusters decrease slightly when deciding on five instead of four clusters, which is seen in Table 3-2, where differences are significant on a 10%-level (5%-level) in 73% (68%) of cases and Table 6-7, where differences are significant in only 69% (64%) of cases. Thus, this further division does not seem to bring substantial additional value (see the appendix for more details on the five cluster solution).

Focus on winter tourism (6 regions):

The seasonal focus of the regions within the fourth cluster ranges from a slight winter tendency to a clear winter focus. The *focus on winter tourism* cluster includes those regions, which show the highest tourism densities and highest concentrations of employment in the tourism sector. The past and current snow situations in the ski resorts of the considered regions belong to the most favorable and the importance of snow as a production factor ranks among the highest compared to all other regions. The same holds true for the average of the highest point of settlement per community, which ranges from 924 m to 1310 m. In terms of the proportion of high quality beds, the regions of the winter tourism cluster more or less equal the all regions' average, except for Lungau, where the share of high quality beds during the summer season is clearly below the all regions' average.

Table 3-2 gives an overview of which clusters differ significantly with respect to which variables according to the Mann-Whitney-U-Test[8]. For example, the *urban and thermal spa tourism* cluster (1) shows significant differences to the *mixed portfolio of lower intensity tourism* cluster (2) only with respect to the proportion of high quality beds, whereas it differs significantly from the *focus on winter tourism* cluster (4) with respect to all variables.

Table 3-2: Significant differences between the clusters

Variable	1 vs. 2	1 vs. 3	1 vs. 4	2 vs. 3	2 vs. 4	3 vs. 4
NightsWi	-	***	***	*	***	**
BedsWi	-	***	***	***	***	**
TourDen	-	**	***	**	***	**
ConcTour	-	-	***	*	***	**
TCperEmpl	-	**	***	-	***	**
SnowDepth	-	***	***	**	**	-
SnowDays	-	***	***	**	***	-
z_max	-	*	***	-	***	**
HighQualWi	***	***	***	**	***	-
HighQualSu	***	***	***	-	***	-

*** Differ significantly at the 0.01 level (2-tailed)
** Differ significantly at the 0.05 level (2-tailed)
* Differ significantly at the 0.10 level (2-tailed)

[8] The Mann-Whithney-U-Test is a non-parametric test in order to assess whether two independent samples of observations are drawn from the same population.

4 Sensitivity analysis

Testing for the robustness of the cluster solution outlined in chapter 3.2 by applying various cluster algorithms shows that the outcome obtained by Ward's method is relatively stable. Using, e.g., "between-groups linkage" as clustering algorithm gives the same solution as illustrated in Figure 3-1 except that Lungau and Wien are indicated as outliers, i.e. they each form clusters on their own. The "centroid clustering" method as well identifies Lungau and Wien as outliers, whereas the remaining classification looks quite similar to the outcome obtained by Ward's method. The only difference concerns the NUTS 3 regions Nordburgenland and Waldviertel, which both are allocated to the first cluster by "centroid clustering" rather than to the second. The result obtained by the algorithm "within-groups linkage" also shows high similarity to the clustering illustrated in Figure 3-1. Differences only concern the NUTS 3 regions Sankt Pölten, Graz and Oberkärnten, which are allocated to the second cluster by the "within-groups linkage" algorithm rather than to the first and third, respectively. The algorithm that results in the most different outcome compared to Ward's method is "median clustering". It identifies Lungau as an outlier and causes another five NUTS 3 regions to be allocated differently compared to the Ward algorithm.

5 References

Backhaus, K., Erichson, B., Plinke, W., and Weiber, R. (2003), *Multivariate Analysemethoden - Eine anwendungsorientierte Einführung (10th edition)*, Berlin: Springer.

Bortz, J. (2005), *Statistik für Human- und Sozialwissenschaftler (6th edition)*, Berlin: Springer.

JOANNEUM RESEARCH (2008), Austrian ski resort database, Graz: Institute of Technology and Regional Policy.

6 Appendix

Table 6-1: Bivariate correlations between the variables available for cluster analysis

Pearson\Spearman	NightsWi	BedsWi	TourDen	ConcTour	TCperEmpl	SnowDepth	SnowDays	z_max	HighQualWi	HighQualSu
NightsWi	1.00	**0.74****	**0.50****	0.40*	**0.61****	0.33	0.40*	0.49**	0.24	0.23
BedsWi	**0.79****	1.00	0.30	0.25	**0.55****	0.25	0.31	0.45**	-0.07	-0.07
TourDen	**0.71****	0.42*	1.00	**0.89****	**0.76****	**0.69****	**0.74****	**0.70****	0.21	0.16
ConcTour	**0.67****	0.43*	**0.97****	1.00	**0.65****	**0.50****	**0.59****	**0.68****	0.16	0.10
TCperEmpl	**0.79****	**0.54****	**0.91****	**0.90****	1.00	**0.86****	**0.89****	**0.89****	-0.17	-0.21
SnowDepth	0.35*	0.11	**0.56****	**0.56****	**0.67****	1.00	**0.96****	**0.70****	-0.15	-0.20
SnowDays	0.35*	0.12	**0.51****	**0.50****	**0.63****	**0.87****	1.00	**0.77****	-0.13	-0.21
z_max	**0.62****	0.36*	**0.73****	**0.75****	**0.83****	**0.67****	**0.77****	1.00	-0.12	-0.18
HighQualWi	0.15	-0.03	0.06	0.05	-0.10	-0.22	-0.29	-0.18	1.00	**0.97****
HighQualSu	0.15	-0.02	0.04	0.01	-0.14	-0.28	-0.34*	-0.24	**0.98****	1.00

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 6-2: Anti-image covariance matrix

	NightsWi	BedsWi	TourDen	ConcTour	TCperEmpl	SnowDepth	SnowDays	z_max	HighQualWi	HighQualSu
NightsWi	0.103	**-0.117**	-0.014	0.024	-0.037	0.014	0.000	-0.026	0.006	-0.014
BedsWi	**-0.117**	0.259	0.028	-0.028	0.006	0.017	0.004	0.038	-0.001	0.010
TourDen	-0.014	0.028	0.034	-0.030	-0.009	0.006	-0.012	0.021	0.008	-0.007
ConcTour	0.024	-0.028	-0.030	0.035	-0.008	-0.005	0.016	-0.026	-0.006	0.004
TCperEmpl	-0.037	0.006	-0.009	-0.008	0.051	-0.031	0.008	-0.020	-0.004	0.008
SnowDepth	0.014	0.017	0.006	-0.005	-0.031	0.174	**-0.115**	0.055	-0.009	0.007
SnowDays	0.000	0.004	-0.012	0.016	0.008	**-0.115**	0.137	-0.088	0.001	0.001
z_max	-0.026	0.038	0.021	-0.026	-0.020	0.055	-0.088	0.158	-0.004	0.006
HighQualWi	0.006	-0.001	0.008	-0.006	-0.004	-0.009	0.001	-0.004	0.033	-0.031
HighQualSu	-0.014	0.010	-0.007	0.004	0.008	0.007	0.001	0.006	-0.031	0.030

Table 6-3: Anti-image correlation matrix

	NightsWi	BedsWi	TourDen	ConcTour	TCperEmpl	SnowDepth	SnowDays	z_max	HighQualWi	HighQualSu
NightsWi	**0.719**	-0.718	-0.245	0.392	-0.515	0.102	0.001	-0.204	0.106	-0.248
BedsWi	-0.718	**0.657**	0.294	-0.296	0.048	0.079	0.021	0.191	-0.013	0.110
TourDen	-0.245	0.294	**0.757**	-0.855	-0.225	0.078	-0.171	0.283	0.227	-0.223
ConcTour	0.392	-0.296	-0.855	**0.740**	-0.191	-0.059	0.234	-0.347	-0.178	0.120
TCperEmpl	-0.515	0.048	-0.225	-0.191	**0.877**	-0.330	0.101	-0.224	-0.102	0.211
SnowDepth	0.102	0.079	0.078	-0.059	-0.330	**0.758**	-0.742	0.330	-0.117	0.093
SnowDays	0.001	0.021	-0.171	0.234	0.101	-0.742	**0.723**	-0.596	0.011	0.017
z_max	-0.204	0.191	0.283	-0.347	-0.224	0.330	-0.596	**0.810**	-0.062	0.092
HighQualWi	0.106	-0.013	0.227	-0.178	-0.102	-0.117	0.011	-0.062	**0.523**	-0.969
HighQualSu	-0.248	0.110	-0.223	0.120	0.211	0.093	0.017	0.092	-0.969	**0.525**

Note: The diagonal elements represent the measures of sampling adequacy (MSA) for the single variables

Table 6-4: Variance explained by the PCA-factors

Factor	Initial Eigenvalues			Sum of squared factor loads for extraction			Rotated sum of squared loads		
	Total	% of variance	Cumulated %	Total	% of variance	Cumulated %	Total	% of variance	Cumulated %
1	5.425	54.250	54.250	5.425	54.250	54.250	4.035	40.352	40.352
2	2.301	23.010	77.260	2.301	23.010	77.260	2.750	27.496	67.847
3	1.177	11.771	89.031	1.177	11.771	89.031	2.118	21.184	89.031
4	0.554	5.535	94.567						
5	0.258	2.581	97.148						
6	0.127	1.273	98.421						
7	0.085	0.848	99.269						
8	0.039	0.392	99.661						
9	0.020	0.198	99.859						
10	0.014	0.141	100.000						

Table 6-5: Rotated component matrix

Variable	Factor 1	Factor 2	Factor 3
NightsWi	0.372	0.854	0.160
BedsWi	0.000	0.933	-0.088
TourDen	0.727	0.556	0.162
ConcTour	0.723	0.550	0.146
TCperEmpl	0.749	0.621	-0.041
SnowDepth	0.900	0.008	-0.169
SnowDays	0.887	0.007	-0.256
z_max	0.812	0.386	-0.141
HighQualWi	-0.085	0.020	0.983
HighQualSu	-0.150	0.035	0.978

Note: Rotation method: Varimax with Kaiser-Normalization

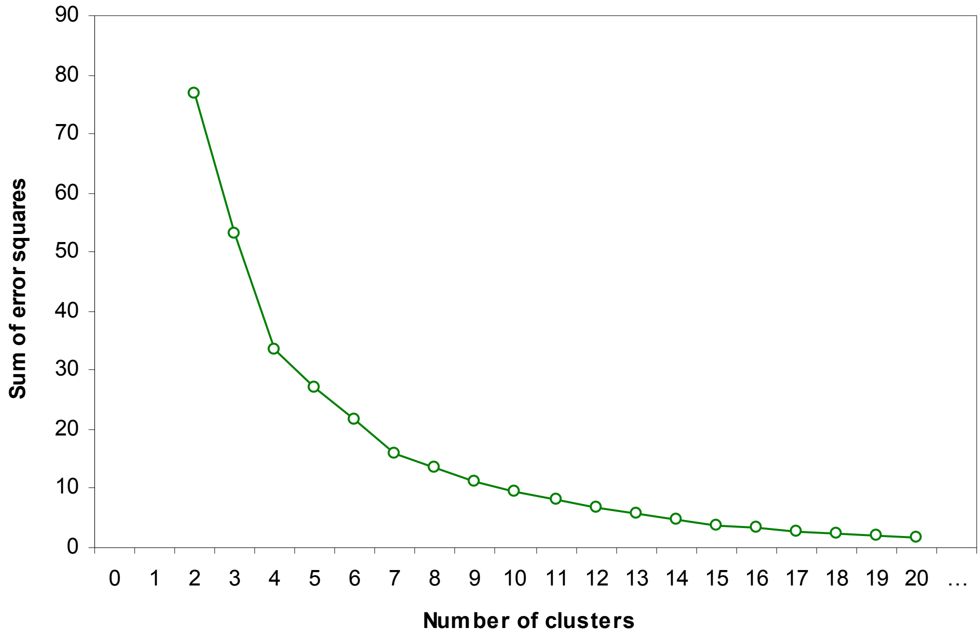

Figure 6-1: Structure chart

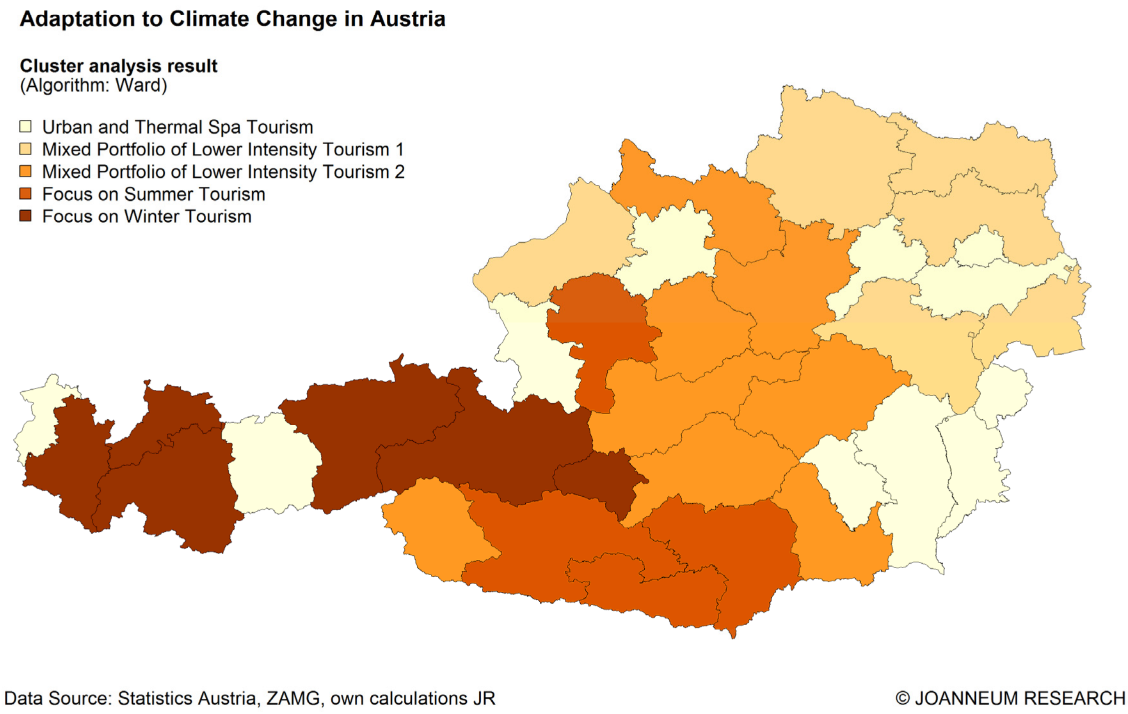

Figure 6-2: Cluster analysis result (5-cluster-solution)

Table 6-6: Means and standard deviations within the four clusters (5-cluster-solution)

Variable	Coefficient	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
NightsWi	mean	40.22	31.65	41.16	24.29	62.30
	sd	4.61	9.58	10.31	8.64	8.51
BedsWi	mean	0.96	0.96	0.99	0.75	1.13
	sd	0.03	0.04	0.02	0.15	0.15
TourDen	mean	7.57	4.54	14.00	22.58	89.90
	sd	6.37	3.03	16.73	19.42	22.05
ConcTour	mean	0.85	0.86	1.07	1.31	2.68
	sd	0.25	0.20	0.45	0.58	0.52
TCperEmpl	mean	559.01	903.79	9770.22	3147.33	13071.88
	sd	1141.91	2213.83	5848.05	3357.09	2500.06
SnowDepth	mean	38.16	6.73	114.90	175.56	154.12
	sd	50.67	16.48	48.42	67.81	53.01
SnowDays	mean	52.52	15.83	123.25	139.51	139.47
	sd	61.20	38.76	13.95	10.80	13.39
z_max	mean	493.13	385.14	802.42	743.81	1097.31
	sd	238.71	196.64	262.65	189.64	147.41
HighQualWi	mean	0.46	0.27	0.23	0.32	0.36
	sd	0.08	0.05	0.03	0.06	0.04
HighQualSu	mean	0.45	0.26	0.23	0.27	0.33
	sd	0.08	0.05	0.03	0.04	0.06

Table 6-7: Significant differences between the clusters (5-cluster-solution)

Variable	1 vs. 2a	1 vs. 2b	1 vs. 3	1 vs. 4	2a vs. 2b	2a vs. 3	2a vs. 4	2b vs. 3	2b vs. 4	3 vs. 4
NightsWi	**	-	***	***	-	-	***	**	***	**
BedsWi	-	*	***	***	-	-	***	***	**	**
TourDen	-	-	**	***	-	**	***	*	***	**
ConcTour	-	-	-	***	-	*	***	-	***	**
TCperEmpl	-	***	**	***	***	**	***	-	***	**
SnowDepth	-	**	***	***	***	***	***	-	-	-
SnowDays	-	**	***	***	***	***	***	-	**	-
z_max	-	***	*	***	***	**	***	-	**	**
HighQualWi	***	***	***	***	-	-	***	**	***	-
HighQualSu	***	***	***	***	-	-	**	*	**	-

*** Differ significantly at the 0.01 level (2-tailed)

** Differ significantly at the 0.05 level (2-tailed)

*** Differ significantly at the 0.10 level (2-tailed)