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165

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Quality of Life in European Regions: A Multi-Criteria Analysis

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Contents

1 Introduction

During the last decades world-wide economies have developed within a rapidly growing process, in general named 'globalisation', in which some countries have succeeded, whereas other countries have progressed only in small steps or have to bear heavy losses in economic power.

This trend totally changes the face of the economy. Until the 1980s cities with the highest access to markets or to raw materials were most successful. But globalisation and the rapidly growing service sector focus not only on traditional location factors, but increasingly also on ‘soft’ factors such as the beauty and variety of landscape or pleasant climatic conditions. In particular so-called footloose industries depend on such factors, and that is why many regions and cities try to improve the quality of their landscape and nature - or at least the image of that quality.

The same globalisation process has also led to wide disparities in living conditions, not only in the world, but also within one country. Moreover, different living standards are strongly connected with different job and income opportunities which itself eventually lead to migration flows from poor to rich regions. Declining economies and unemployment are the main reasons for migration. A second force leading to migration flows are political suppression or persecution. These are the two main pillars of migration. A third numerically small but for some regions very important factor is retirement migration. This is not a new phenomenon, it has been observed since ancient times, but in parallel to improving living standards the number of pensioners who want to spend their retirement age in the countryside, at the seaside or other attractive places with a high quality of life has increased during this century.

For both the locations of modern firms and the destinations of migrants, the quality of the natural environment is of great interest. But how are such qualitative factors to be measured, when trying to compare the landscape of different regions, estimating the settlement potential of footloose industries or forecasting pensioner migration flows?

The purpose of this working paper is to introduce a *quality of life* indicator for the regions of the European Union, which can be used in quantitative methods. This paper tries to transform individual, subjective preferences into objective, quantitatively measurable indicators. The author is aware that this can only be a first attempt and that some of the assumptions leading to the indicator might be debatable. So the paper is to be interpreted as a contribution to the discussion about how to introduce qualitative aspects of landscape and climate into quantitative models of location and migration behaviour.

There have been several similar studies which tried to measure ‘qualities’, ‘well-being’ or the ‘quality of life’, but almost always in the context of living conditions in cities or agglomerations such as Coughlin 1973, Liu 1976 and Findlay *et al.* 1988a. These studies usually came up with city rankings based on social, health and - to some extent - environmental indicators. In contrast to these studies, the *quality of life* indicator presented here is based on regions and focuses on climatic, natural and environmental and level-of-services aspects. There had been only very few comparable studies in evaluating nature and landscape on a regional level, such as Kiemstedt (1967).

There are as many different definitions of *quality of life* as there are studies. Some definitions rather focus on social and psychological aspects, others on health, and only very few on the environment, but in general, *quality of life* is normally taken to mean the general well-being of people and the quality of the environment in which they live. "For some, it concerns personal well-being and satisfaction or happiness while for others, it is concerned with living conditions of a place." (QOLNET 1999) This approach clearly focuses on the latter aspect of living conditions - not for a single place, but for entire regions. Living conditions are meant here as climatic, environmental and infrastructural preconditions for subjective human well-being.

The *quality of life* indicator here is derived by means of a multi-criteria analysis (MCA) performed within the geographic information system ARC/INFO. The first part of this paper describes the definition of the indicator system for the multi-criteria analysis, the generation and weighting of the subindicators and the description of the results. The second part consists of a technical annex describing the implementation of the multi-criteria analysis within the GIS in terms of data management, spatial units, program structure and AML source code. However, the theory of multi-criteria analysis itself is not discussed. There are many publications available related to that field (e.g. Edwards, 1954; Edwards and Tversky, 1967; Zangemeister, 1970)

This working paper originated from the project “Socio-Economic and Spatial Impacts of Transport Infrastructure Investments and Transport System Improvements” (SASI) commissioned by the General Directorate VII (Transport) of the European Commission as part of the Fourth Framework Programme of Research and Technology Development. In that project the *quality of life* indicator serves to estimate net migration rates in a population forecasting model, especially considering retirement migration of elder people.

The author greatly appreciates the contributions of Meinhard Lemke and Stefanie Roeder for producing and maintaining the spatial database necessary and the contributions of Franz Fürst, Klaus Spiekermann and Michael Wegener for suggestions and discussions during the development of the indicator system.

2 Basic Concept

The overall indicator of *quality of life* developed here consists of several evaluated and aggregated indicators. This aggregation is done by using a multi-criteria analysis implemented within a GIS framework (ARC/INFO). The indicator selection must be seen under the objective of developing an indicator which covers the attractiveness of regions for retirement migrants - not for all migrants. Therefore social, economic and health aspects of the *quality of life* are left aside.

According to Kiemstedt (1967, S.17), nature and landscape are influencing individual impressions on three levels:

Firstly, they are a bearer of perceptible, optical impressions. Secondly, they enable balancing activities to people and finally they influence people by direct, physical climatic impacts. These three levels are represented by the following three categories:

1. Climate (direct, physical impacts)
2. Landscape (perceptible, optical impressions)
3. Touristic Facilities (enabling balancing activities)

The *climate* category takes into account the fact that people and service industries prefer regions with rather warm and rainless climate and long sunshine periods. The attractiveness and variety of the *landscape* also play a prominent role in such decisions. Particularly migrants, whose choice is not exclusively determined by economic considerations, opt for regions with a high recreational value, i.e. picturesque landscapes and forest suitable for leisurely walks or excursions. The number and quality of leisure and *touristic facilities* is also an important point. These facilities reflect the supply level that is required, because, although *landscape* aspects are very important, people do not want to dispense with all the modern conveniences. In this respect the t*ouristic facilities* indicators measure not only the number of hotels or swimming pools, but represent at the same time the overall supply level within a region in terms of shopping opportunities, medical care etc.

So the basic concept of this approach is similar to the one Kiemstedt developed. Beyond that, Kiemstedt´s approach is limited to a number of only four indicators, namely the length of sea shores and forest edges, the relief energy, the shares of different land use categories of the total area and finally temperature and rainfall covering climatic aspects. This limitation does not seem to be sufficient enough for model purposes in this approach, so that the number of indicators is increased.

The *quality of life* indicator here covers all of the above issues with the following nine indicators (the respective categories are indicated in brackets):

- Temperature (Climate)

- Rainfall (Climate)
- Sunshine (Climate)
- Slope Gradient (Landscape)
- Elevation Difference (Landscape)
- Open Space (Landscape)
- Development of Shores (Touristic Facilities)
- Degree of Touristic Development (Touristic Facilities)
- Attractive Towns (Touristic Facilities)

Each category consists of three indicators. According to a fundamental rule of multi-criteria analysis, all these indicators are set up as orthogonal categories with no aspect or causal relationship covered in more than one indicator. However, *slope gradient* and *elevation difference* can be grouped together as *relief energy*.

To obtain the overall *quality of life* indicator, the nine individual indicators have to be combined. Following the multi-criteria analysis, this is done by assigning individual weights to each indicator, multiplying the observed indicator values with these weights and finally adding up those products.

Figure 1 shows the hierarchy of the indicators and their weights in brackets. The weights are based on expert ratings at IRPUD. The three categories (*climate*, *landscape*, *touristic facilities*) are weighted with 33.3 percent each. Within the *climate* category, the indicators *temperature* and *rainfall* both have a weight of 30 percent whereas *sunshine* has a weight of 40 percent. Within the *landscape* category, the *slope gradient* and the *elevation difference* indicators have weights of 20 percent and 30 percent, respectively, i.e. taking both together as the relief energy, they have the same weight as the o*pen space* indicator (50 percent). Considering the *touristic facilities* category, the main indicator is the *development of shores* with a weight of 50 percent, whereas the *attractive towns* and *touristic area* indicators both have a weight of 25 percent. The underlying assumption is that seaside regions are more attractive than hinterland regions. Moreover, historical or other attractive towns are to some extent an attraction factor although they are unlikely to be the only criterion in the choice of a migration target or footloose industry settling.

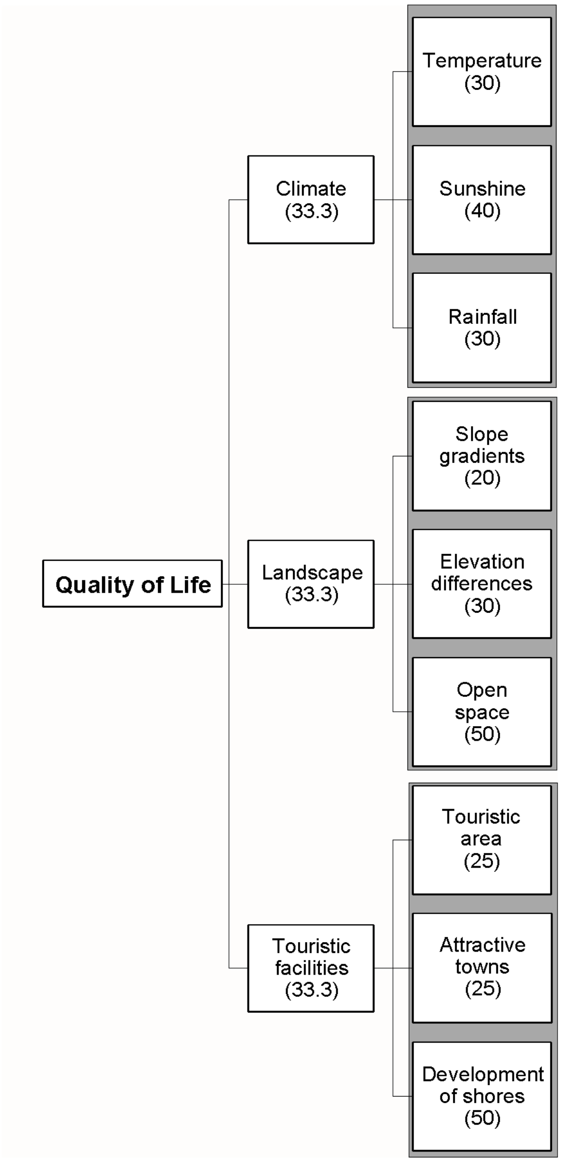


Figure 1. Hierarchy of the quality of life *indicator.*

3 Indicators for Measuring Quality of Life

The following sections introduce and explain the definitions and when necessary the generation principles of the indicators. All of them are either directly derived from various sources (e.g. *rainfall*, *temperature*) or generated by individual generation functions (*touristic area*, *development of shores*). However, in each case mapping functions transform the observed values into utilities which are then integrated into the multi-criteria analysis. The mapping functions are pre-defined scores, which define the ideal situation and determine the percentage by which a particular indicator value achieves this goal. The degree of goal achievement is called utility.

In the following indicator descriptions, each indicator is illustrated by two or three figures:

1. A diagram displaying the frequency of observed indicator values in histogram form and the mapping function in dotted lines. In these diagrams the observed indicator values are given on the x-axis (clustered in classes), while the left y-axis gives the frequency and the right y-axis indicates the mapping function (always from 0.0 to 1.0) which converts the observed values into utility values which are used in the multi-criteria analysis. If necessary, a second diagram shows the generation function of the indicator.

2. A map showing the indicator values for Europe.

The following explanations focus on the generation principles and the mapping functions of the indicators. A general discussion on the indicators presented here, i.e. the question on which elements or dimensions of environment should be addressed and how important those elements are, can not be done within the framework of this working paper.

3.1 Indicator 1: Temperature

The long-time average temperatures in July are derived from a pan-European isotherm map (Westermann 1997). They are entered manually into the GIS database and are expressed in degrees centigrade.

Figure 2 illustrates the histogram and the mapping function of this indicator. Additionally, Figure 3 shows the distribution of long-time average temperatures in July across Europe. As it can be seen, most of the regions have average temperatures between 15 °C and 18 °C or between 18 °C and 20 °C, respectively. Some outlying cold (Tirol, Scotland, Scandinavia) or warm (Greece) regions can also be observed. Surprisingly the coldest regions can be found in Austria instead of Scandinavia. Probably this is because temperatures in Austria are measured at weather stations on the mountains high above sea level.

It is assumed, that regions with relatively high temperatures are more attractive than regions with low temperatures. Regions with less than 10 °C average temperature have a goal achievement of zero. So the mapping function grows linearly from 10 °C until 22 °C, when the full goal achievement is reached. However, temperatures should not be too high, because there would be negative impacts on health and vegetation. For this reason the mapping function decreases beyond a temperature of 25 °C.

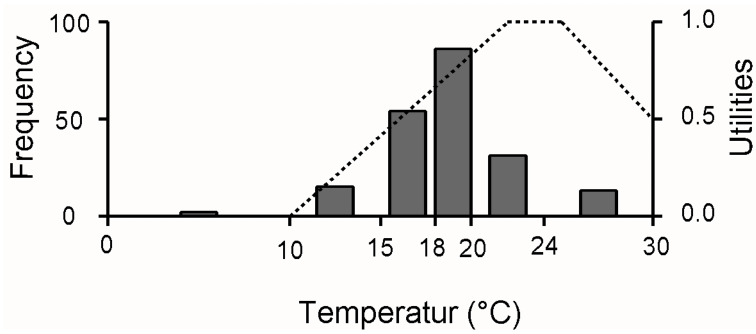


Figure 2. Histogram and mapping function for the temperature *indicator.*

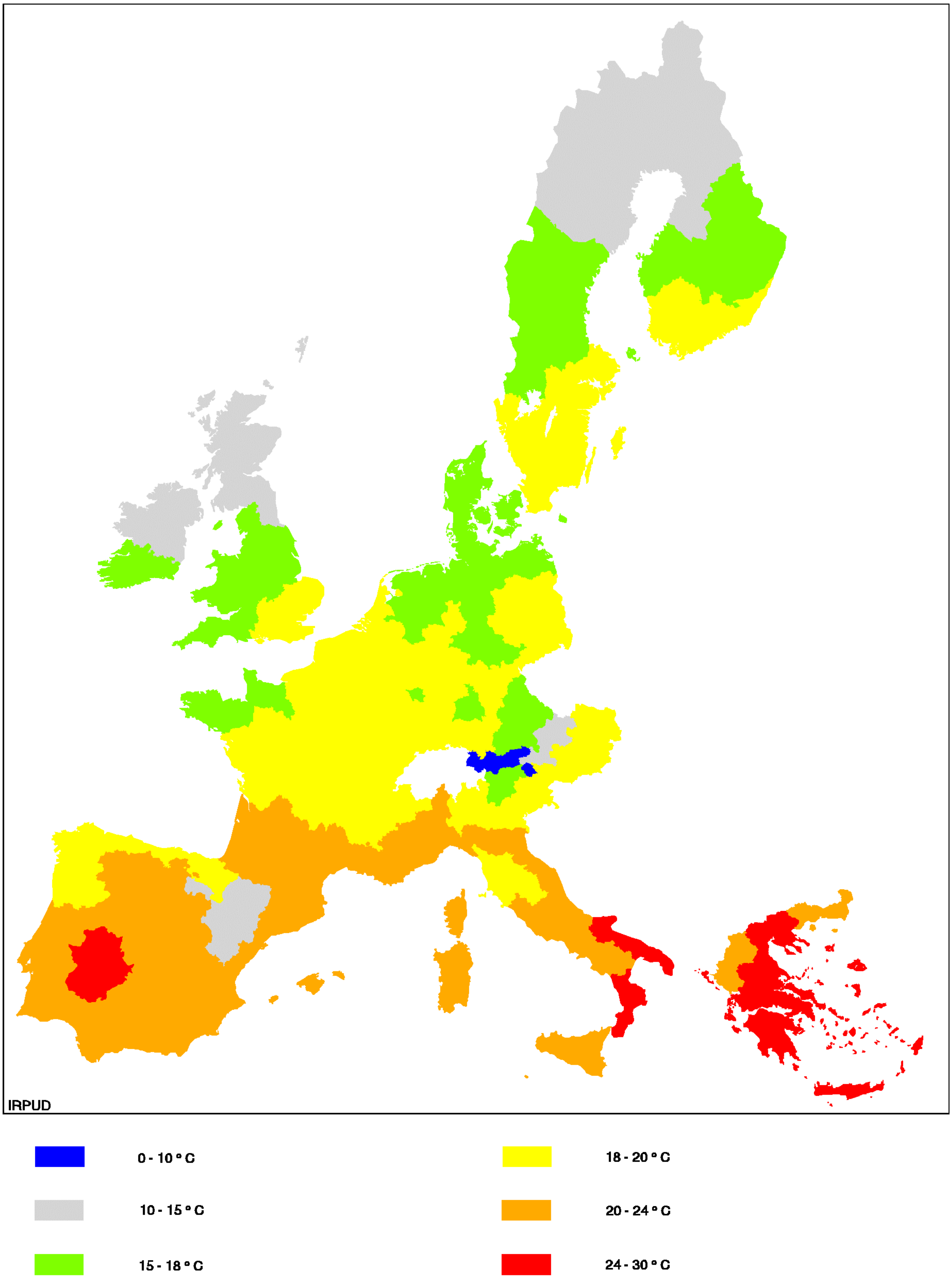


Figure 3. Average temperatures in July (Source: Westermann, 1997).

3.2 Indicator 2: Sunshine

Although there is a close relationship between temperature and exposure to sun radiation, high temperatures do not necessarily imply high values for average daily *sunshine*. Because information on the number of sunshine hours for the entire European continent is not available, the daily global radiation on the ground is used as a proxy for sunshine. The radiation data are given as the average over all months of the years 1966-1975 in kWh/m**5** and are based on digitised isopyr (= isolines of daily irradiation) maps taken from Palz and Greif (1995). The radiation depends on latitude, coastlines, ground topography, slope gradient, lee effects, astronomical factors (determining the solar altitude pattern across the day) and finally on atmospheric clearness.

Figure 4 shows the frequency distribution and the mapping function. Most regions have radiation rates between 2.5 and 3 kWh/m^2. However, there is a clear increase in radiation rates from Scandinavia (less than 2.2 kWh/m^2) to regions in the south of Spain, Greece and northern Africa (more than 4.8 kWh/m^2). Figure 5 displays the long-time average radiation across Europe in kWh/m^2.

It is assumed that the higher the radiation, the better the goal achievement. But like temperature, extreme radiation rates are adverse to health and vegetation. The mapping function therefore increases from 2.25 kWh/m^2 to 3.8 kWh/m^2, where it reaches full goal achievement, and decreases beyond 4.5 kWh/m^2 to a utility of 0.5 at 5 kWh/m^2.

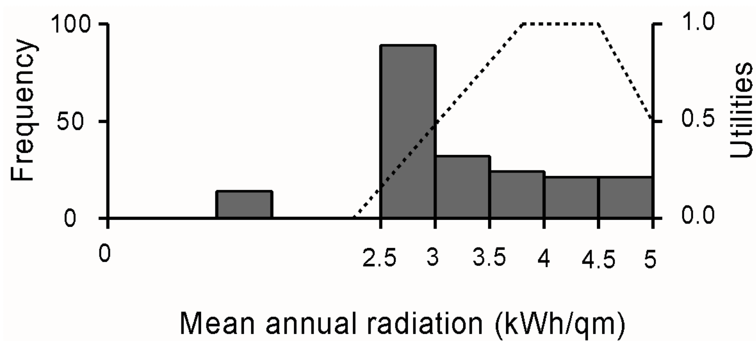


Figure 4. Histogram and mapping function for the sunshine *indicator.*

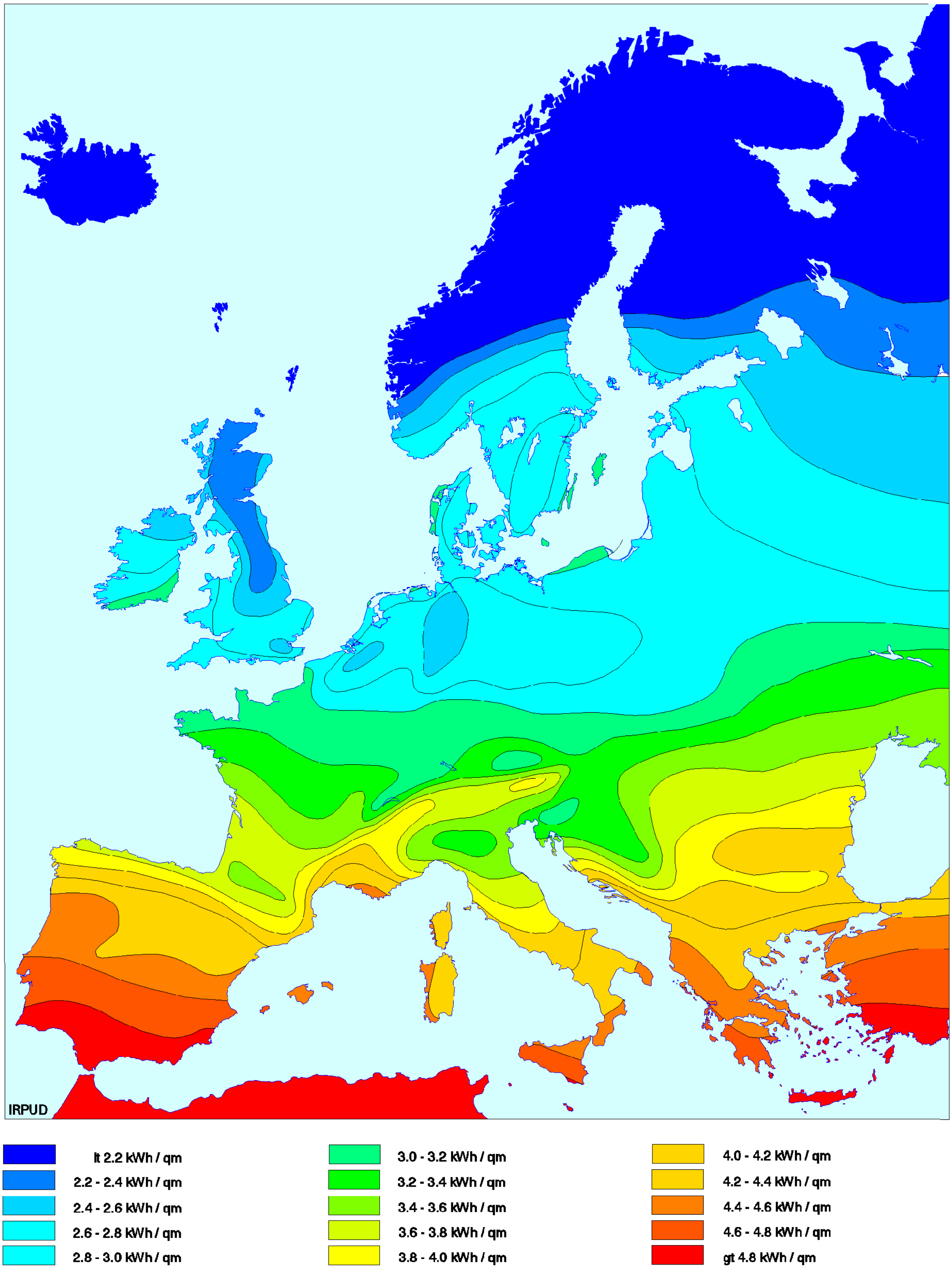


Figure 5. Mean annual radiation across Europe in kWh/m^2 (Source: Palz and Greif, 1995).

3.3 Indicator 3: Rainfall

The *rainfall* indicator is measured as the long-time average yearly amount of rain. It is transferred manually from a European rainfall map (Westermann, 1997) to the system of regions. The rainfall is indicated in millilitres.

Figure 6 illustrates the frequency curve and mapping function for this indicator and Figure 7 shows the distribution of average annual rainfall across Europe for the system of regions used. Most regions in Germany, Benelux, southeast England and southern Scandinavia have 500 ml to 750 ml average yearly rain. The highest amount of more than 1,250 ml of rain occurs in the Alps as well as in the western coastal regions of Portugal, Spain and the United Kingdom.

It is assumed that regions with less rain are more attractive than regions with more. Nevertheless, a minimum level of rain is required in order to preserve vegetation and landscape which contribute to a region's attractiveness. For this reason the mapping function is increasing from 350 ml until 600 ml, where the goal achievement reaches 1.0, and decreases from 800 ml onwards.

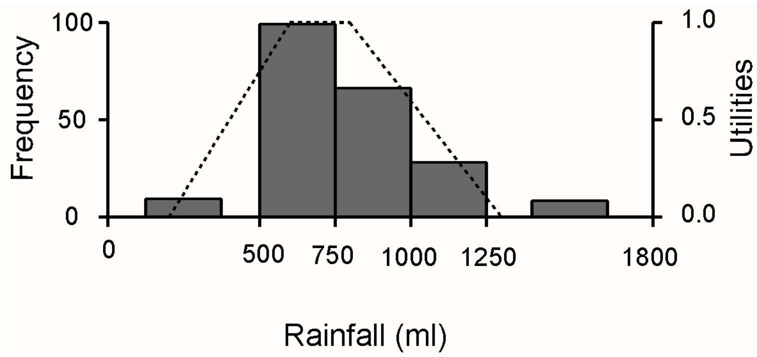


Figure 6. Histogram and mapping function for the rainfall *indicator.*

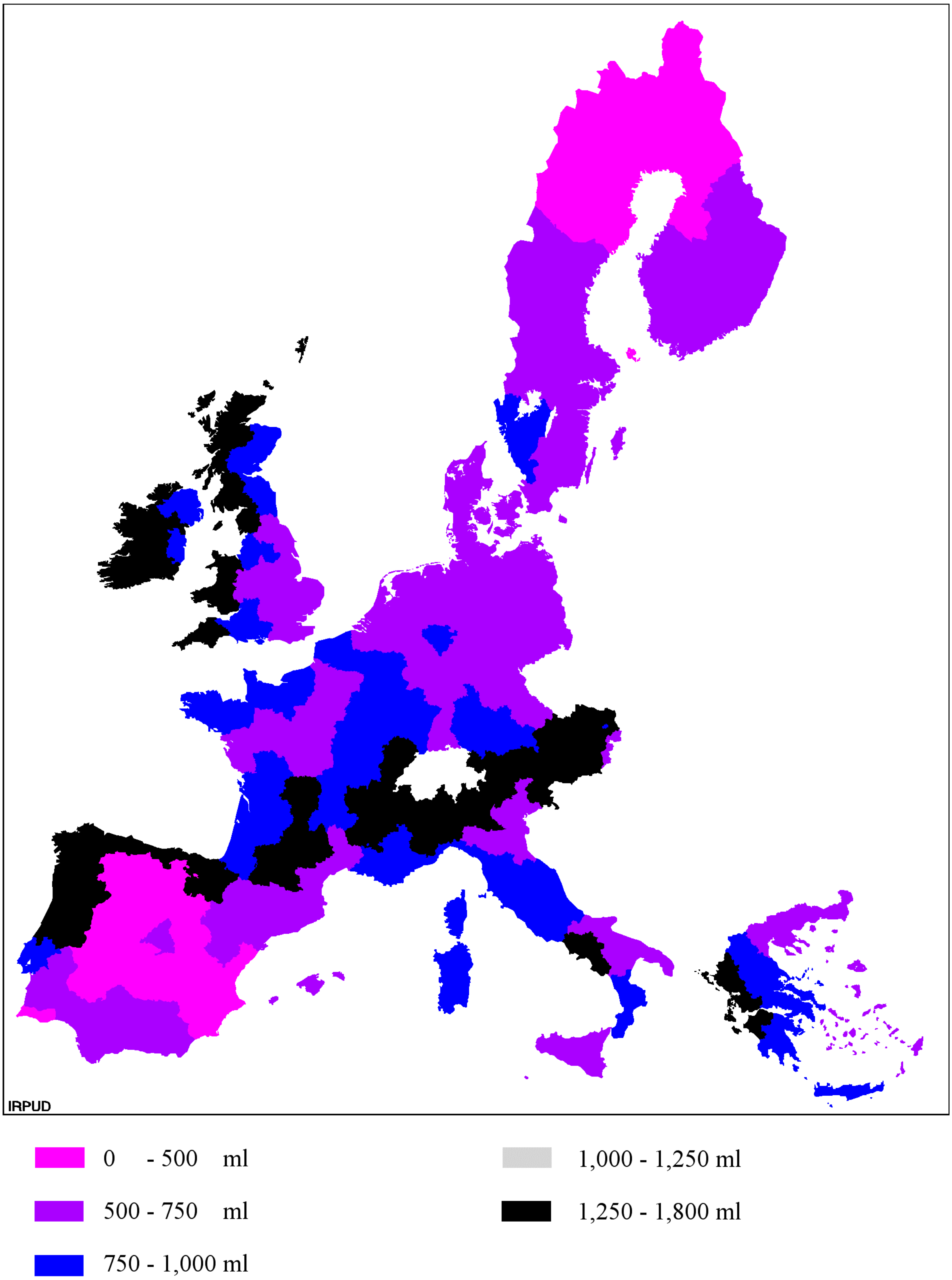


Figure 7. Average yearly amount of rain across Europe (Source: Westermann, 1997).

3.4 Indicator 4: Slope Gradient

The *slope gradient* indicator is used as a proxy for surface variety. It is derived from a three-dimensional surface elevation model from Europe produced and maintained at IRPUD (1998). For every region different slope gradients are determined and the average gradient is calculated weighted by area.

Figure 8 shows the frequency distribution and mapping function for *slope gradients*, while Figure 9 shows the European relief. Most of the regions (almost 150) have average slope gradients of less than 5 percent, only very few regions in the Alps of more than 15 percent. The higher the average slope gradient, the higher the goal achievement. This means that the mapping function is constantly increasing from zero slope to 18 percent slope. Beyond this point, all slope gradients have full goal achievement.

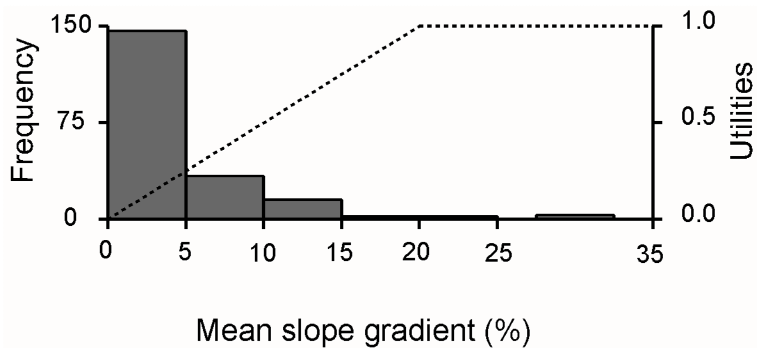


Figure 8. Histogram and mapping function for the slope gradient *indicator.*

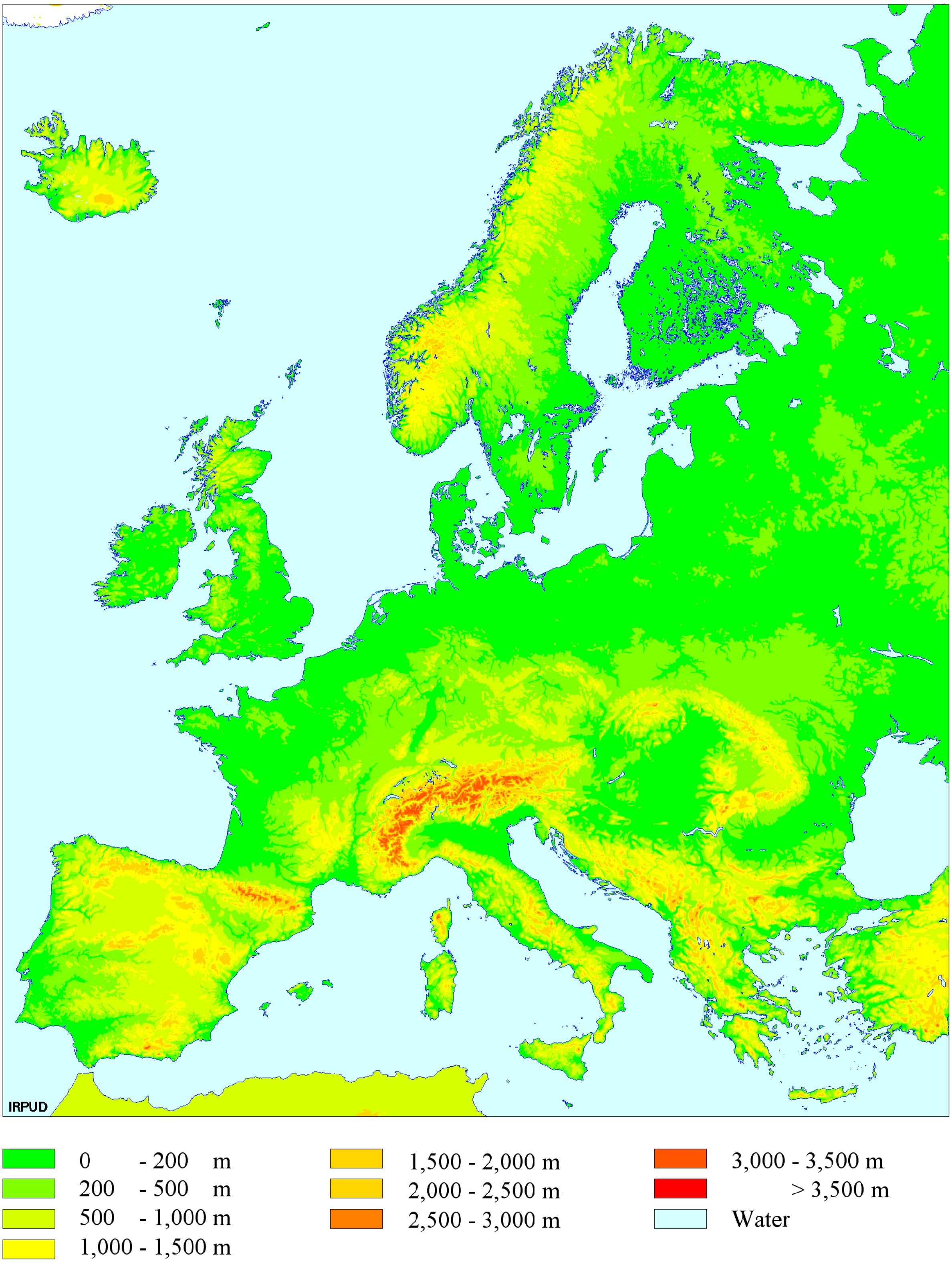


Figure 9. European topography (Source: IRPUD, 1998).

3.5 Indicator 5: Elevation Difference

This indicator is the second indicator contributing to surface variety. Like the average slope gradient indicator, the elevation above sea level is derived from a European three-dimensional surface elevation model (IRPUD, 1998). *Elevation differences* are calculated as the difference between the maximum and minimum elevation above sea level within one region.

As Figures 10 shows, the frequency distribution is very balanced. Some ten regions show differences of more than 3,000 metres, some other ten differences between 1,000 and 1,500 metres or between 2,000 and 2,500 metres, respectively. The highest differences can be found in the French and Italian Alps, in the Pyrenees and in the Sierra Nevada in Spain. The lowest differences, as expected, are in the Benelux, Denmark, southern Scandinavia, United Kingdom and the northeast of Germany.

The mapping function is comparable to the one of the *slope gradient*. Again, the higher the difference, the higher the goal achievement. This means that the mapping function is increasing from zero goal achievement at 100 metres up to full goal achievement at 2,000 metres elevation difference. Beyond this point each difference has full goal achievement. Figure 11 shows the elevation differences in metres by region.

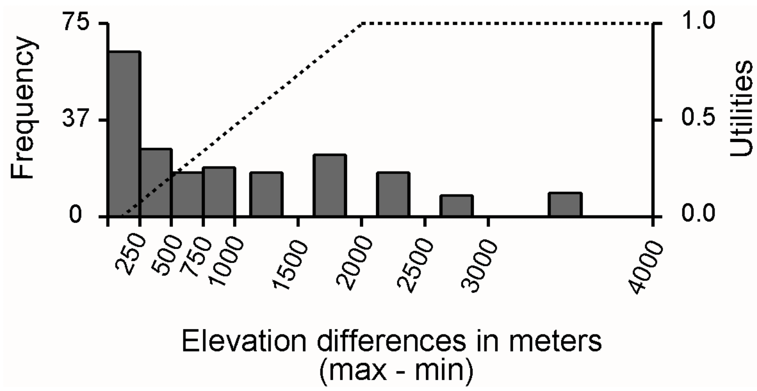


Figure 10. Histogram and mapping function for the elevation difference *indicator.*

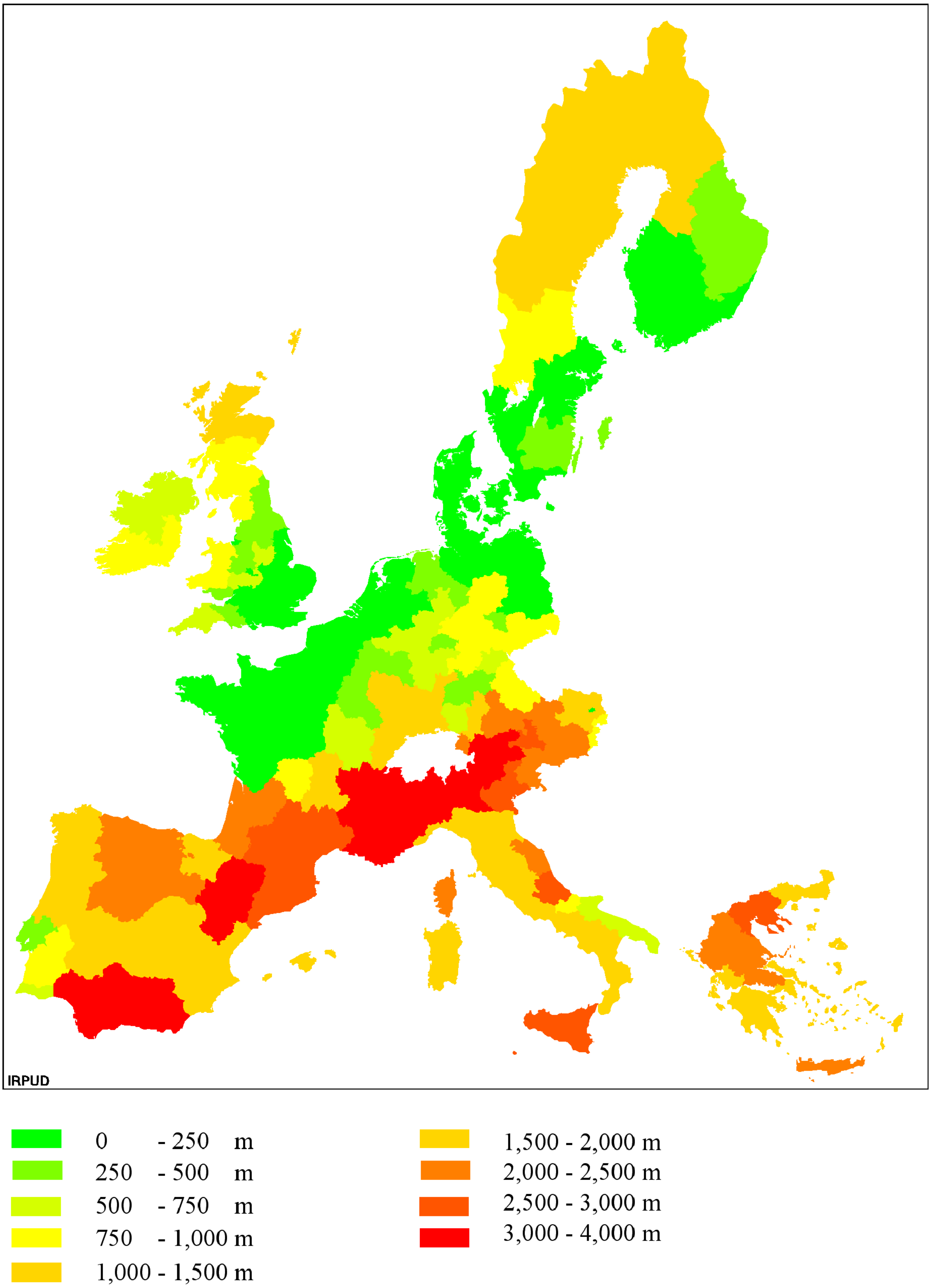


Figure 11. Elevation differences *in metres in Europe (Source: IRPUD, 1998).*

3.6 Indicator 6: Open Space

It is undisputed that under recreational aspects *open space* plays a prominent role. However, *open space* is also used as a proxy for the variety of landscape, flora and fauna. This indicator measures the percentage of open space of the area of a region. Open space includes forest areas as well as agricultural areas and arable land. The information is derived from the Eurostat Regio Databank (Eurostat, 1998).

Figure 12 displays the histogram and the mapping function for this indicator. Most regions (almost 100) have a percentage share of open space of about 60 to 80 percent. The regions with the lowest shares of less than 40 percent are regions in the Benelux, the three city states in Germany, and most Greek regions, as it is illustrated in Figure 13.

A minimum of 10 percent open space on the total area is considered absolutely necessary. A lower percentage is considered as totally build-up areas (agglomerations) and has a goal achievement of zero. The goal achievement is increasing to 80 percent, where full goal achievement is reached.

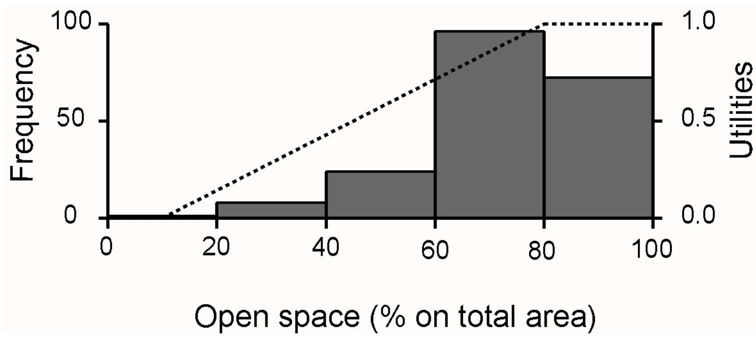


Figure 12. Histogram and mapping function open space *indicator.*

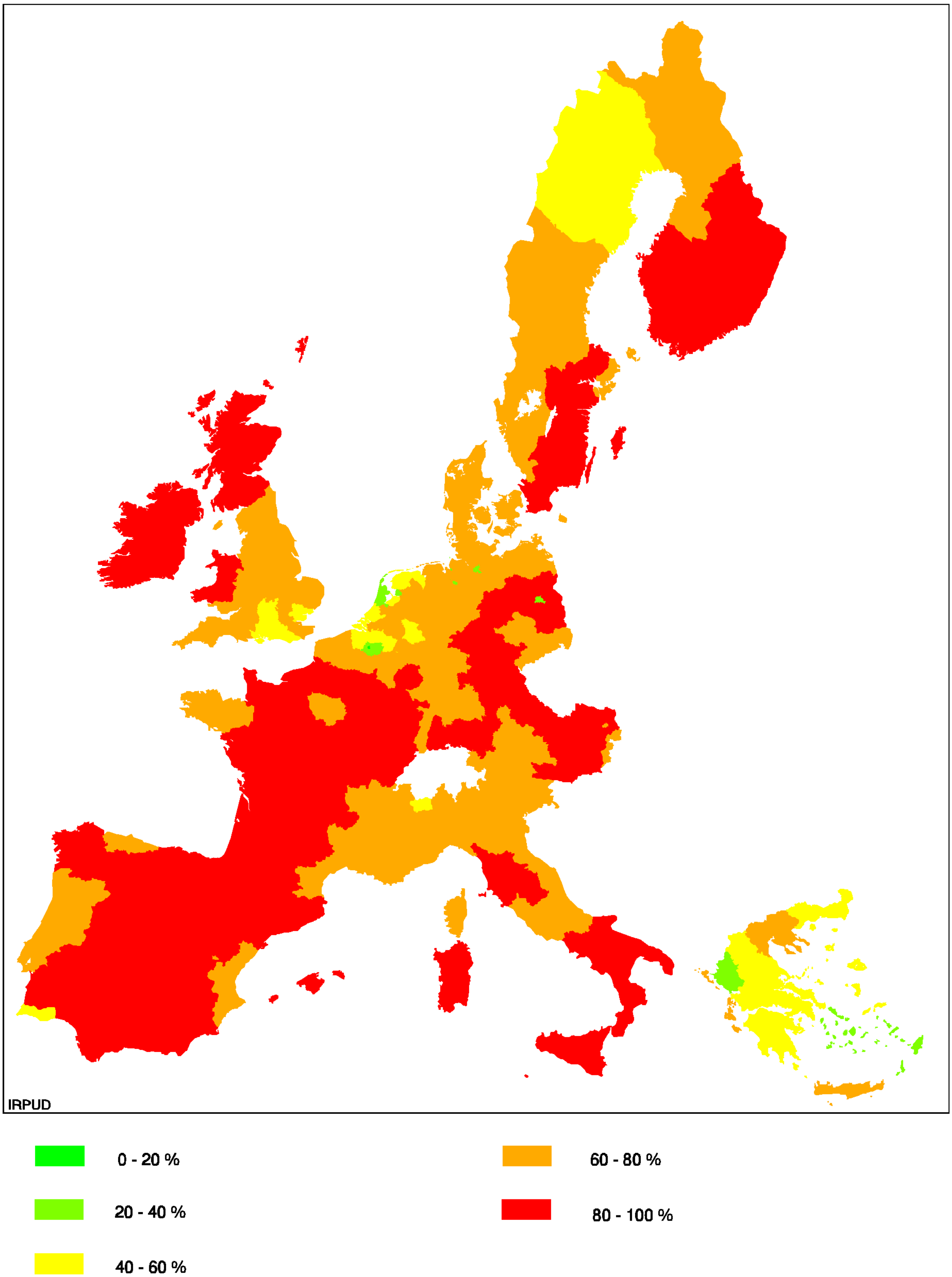


Figure 13. Open space *in Europe (Eurostat, 1998).*

3.7 Indicator 7: Degree of Touristic Development

This indicator represents the degree of development of regions with touristic facilities such as footpaths, rest places, hotels, other recreation facilities, mountain railways, tourist information services etc. Unlike the *development of shores* indicator, this indicator does not consider seaside regions but focuses on hinterland regions. Touristic facilities in agglomerations or other cities are not measured by this indicator but by the *attractive towns* indicator. Although this indicator measures touristic facilities, it is assumed that these facilities have also positive impacts on migration flows. Referring to Ritter (1966), the following five categories can be differentiated:

- Areas which are totally affected and formed by tourism
- Areas which are locally affected and formed by tourism
- Areas with tourism but which are only sparsely formed by touristic facilities
- Areas which are not affected and not formed by tourism
- Agglomerations (no touristic areas)

Because the data source used is differentiated by these five qualitative categories, a generation function is used to transform this qualitative information into computable quantitative values, i.e. to transform them into the *degree of touristic development* indicator. This function is displayed in Figure 14.

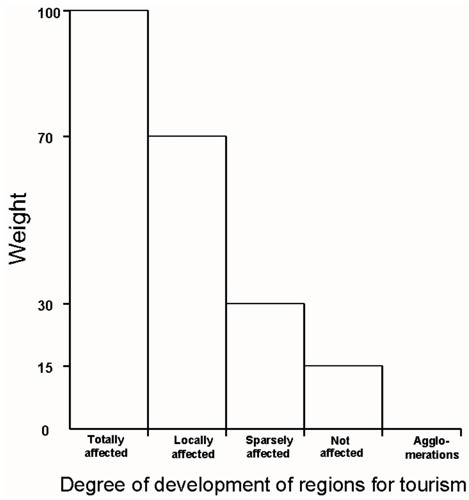


Figure 14. Generation function for the degree of touristic development *indicator.*

To calculate the regional average of the indicator, totally affected areas have a weight of 100, locally affected areas a weight of 70, sparsely affected areas a weight of 30, not affected areas a weight of 15 and agglomerations a weight of zero. The share of each category's area on the total area of the region is then multiplied by its weight and the five categories are added up. For example, one region has a total area of 100,000 km^2 of which 5,000 km^2 are totally, 25,000 km^2 locally, 26,000 km^2 sparsely formed by tourism and 40,000 km^2 are not affected at all. In addition, there is an agglomeration area with 4,000 km² in that region. The index value for that indicator will be 36.3. Table 1 illustrates the example:

Table 1. Example for calculating the degree of touristic development indicator for a region.

Categories	Area (km^2)	Share of total area	Weight	Development indicator
Totally affected	5,000	0.05	100	5
Locally affected	25,000	0.25	70	17.5
Sparsely affected	26,000	0.26	30	7.8
Not affected	40,000	0.40	15	6
Agglomerations	4,000	0.40	0	0
Total	100,000	1.00		36.3

Figure 15 shows the frequency distribution and the mapping function. Most indicator values range from 15 to 60 points (about 120 regions). Some 50 regions obtain indicator values between 60 and 90 points.

The degree of goal achievement is increasing until a value of 70, when full goal performance is reached. Beyond 80 the goal performance is decreasing because a higher degree of development might be useful for short-time tourism, but might be adverse to *quality of life* because it implies overcrowding and other negative phenomena.

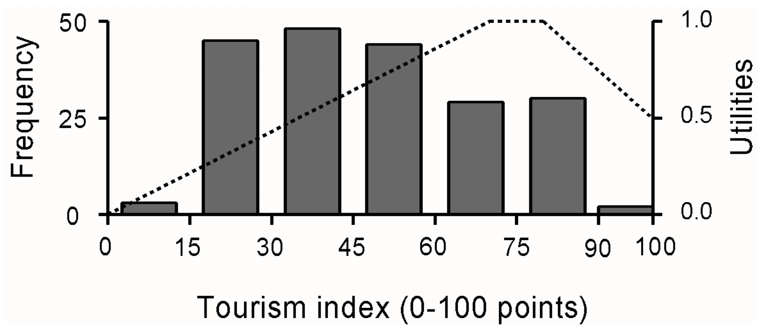


Figure 15. Histogram and mapping function of the degree of touristic development *indicator.*

Figure 16 shows the touristic development map which displays the different degrees of development of touristic facilities in European regions which are input to the generation function.

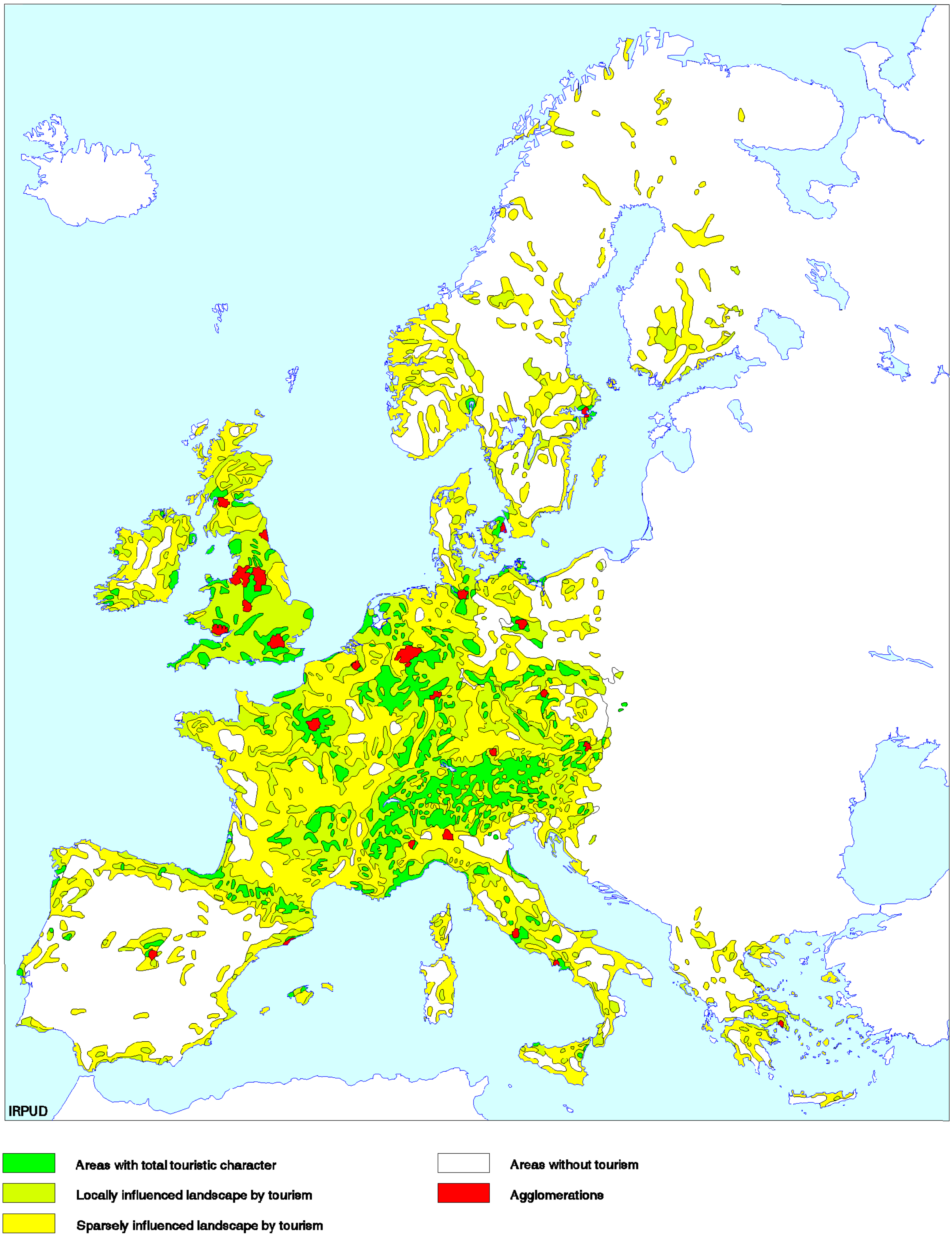


Figure 16. Degree of touristic development *across Europe (Source: Ritter, 1966).*

3.8 Indicator 8: Attractive Towns

For many people not only leisure opportunities in the countryside are important but also attractive cities and towns. The *attractive towns* indicator counts the numbers of attractive historical and winter sports towns per region as well as the number of health and seaside resorts. All these towns ensure a certain supply level with shopping, meeting and sightseeing opportunities. The more attractive towns are located within one region, the higher the level of supply facilities and consequently the higher the attractiveness.

This indicator is interpreted as an additional asset of regions. The different kinds of towns are not weighted; their numbers are simply added. The reason for not weighting them is that it would require further investigations into individual preferences for different types of towns. Some people prefer historical towns, some winter sports, others health resorts etc. To weight them would require information about the number of guests in each town category for the whole of Europe, which is not available. To eliminate the impact of the size of the regions, the number of towns is divided by the regions' area. The information is taken from a European tourist travel map in Westermann (1983).

Figure 17 illustrates the histogram and the mapping function of this indicator, whereas Figure 18 displays the locations of the towns. Almost 150 regions have less than 2.5 towns per 10,000 km^2. A value of 10 or more towns per 10,000 km^2 means full goal performance.

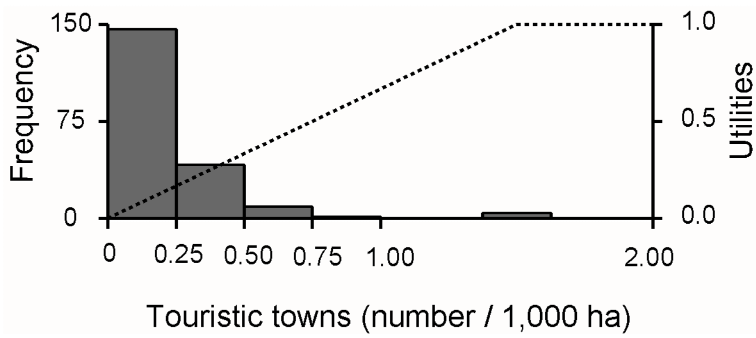


Figure 17. Histogram and mapping function of the attractive towns *indicator.*

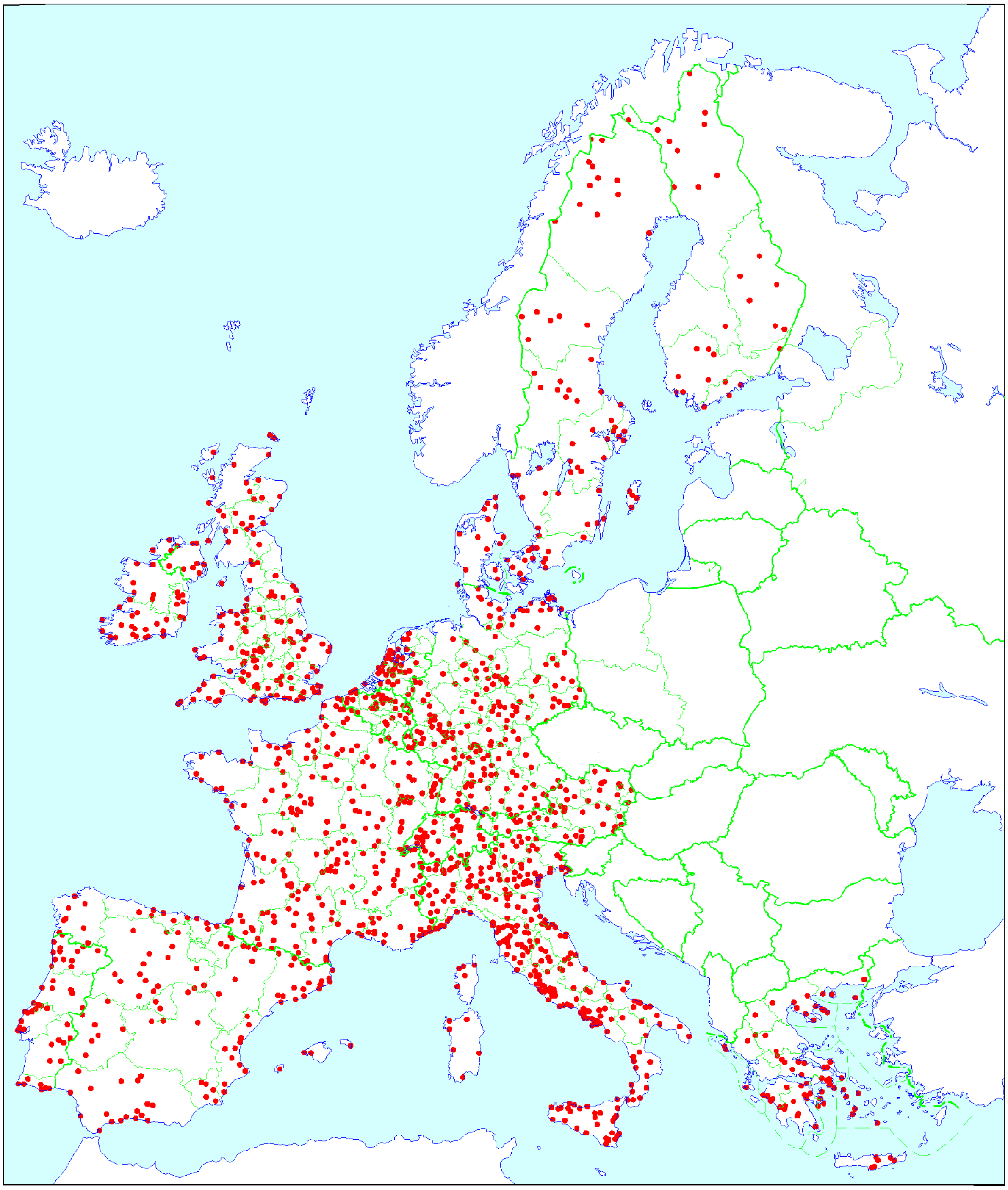


Figure 18. Distribution of attractive towns *across Europe (Source: Westermann, 1983).*

3.9 Indicator 9: Development of Shores

For many people the development and supply of touristic facilities (hotels, bars, swimming pools, sports and leisure facilities, museums etc.) especially at the seaside play a prominent role. Ritter (1966) has produced a European map showing the *development of shores* differentiated by the following four categories:

- fully developed shores
- well developed shores
- sparsely developed shores
- no developed shores

Developed shores include not only the number or the length of beaches for swimming, but also hotels, sports and leisure facilities, tourist information services, cultural events, retail facilities etc., i.e. every facility related to tourism and accommodation of guests. Because the data source differentiates these four qualitative categories, they first have to be aggregated to one single *development of shores* indicator by using a generation function in a similar way as for the *touristic areas* indicator (Figure 19):

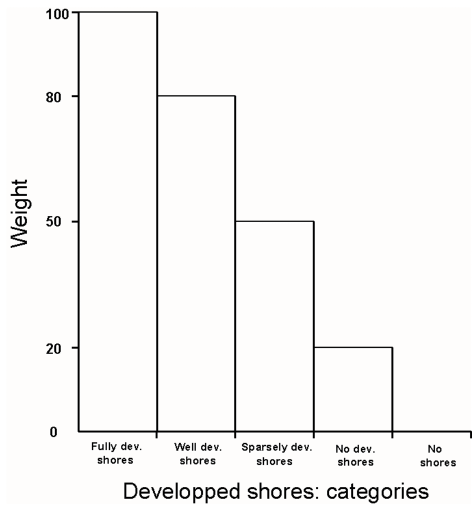


Figure 19. Generation function of the development of shores *indicator.*

Each of the four categories is measured as the share of the total shore length of the region. The shares of the four categories are multiplied by different weights. The first category (fully developed shores) is weighted by 100, the second category (well developed shores) by 80, the third category by 50 and the fourth category (no developed shores) by 20 (not zero because some people may like isolated, non-developed shores and to distinguish between seaside and landlocked regions). Isolated shores are weighted by 20 only, assuming that some base-level supply of facilities has a greater importance than absolute lonely shores. Regions without coasts at all get zero weight.

For example, a region with 500 km coastline, of which 50 km are fully developed, 40 km well developed, 260 km sparsely developed and 150 km not developed, the overall index value is 48.4. Table 2 summarises the calculation:

Table 2. Example for the generation process of the indicator.

Categories	Length (km)	Share of total length	Weight	Development of shores index
Fully developed	50	0.10	100	10.0
Well developed	40	0.08	80	6.4
Sparsely developed	260	0.52	50	26.0
Non developed	150	0.30	20	6.0
No shores	0	0.00	0	0.0
Total	500	1.00		48.4

Figure 20 displays the histogram and the mapping function of the *development of shores* indicator. Most regions (about 90) obtain index values of less than 20 points. The other four classes contain some 30 to 40 regions each.

In general, the higher the index value, the higher the goal achievement. Indices between 70 and 80 reach full goal achievement. However, similar to the *touristic area* indicator, higher values indicate total development for short-time tourism with negative consequences such as overcrowded, environmental and social problems. So the mapping function is decreasing after 80 points.

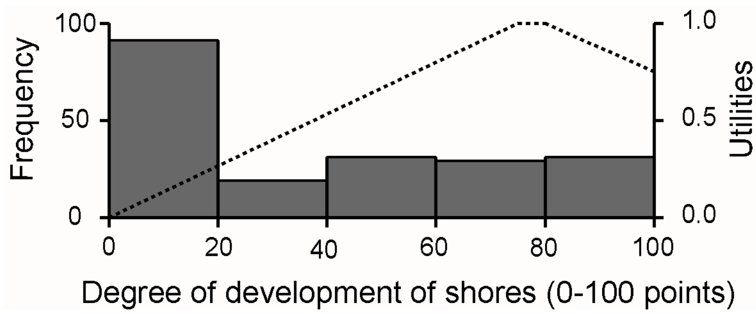


Figure 20. Histogram and mapping function of the development of shores *indicator.*

Figure 21 shows a map of shores differentiated by the four categories.

Comparing the last three indicators,
- the *touristic area* indicator considers the development of facilities of the countryside,
- the *attractive towns* indicator considers the development of facilities of the cities and agglomerations,

- the *development of shores* indicator considers the development of facilities of the seaside.

As mentioned above, the *touristic area* and *development of shores* indicators represent not only touristic facilities in the narrow sense but at the same time the overall supply level within a region in terms of shopping opportunities, medical care etc.

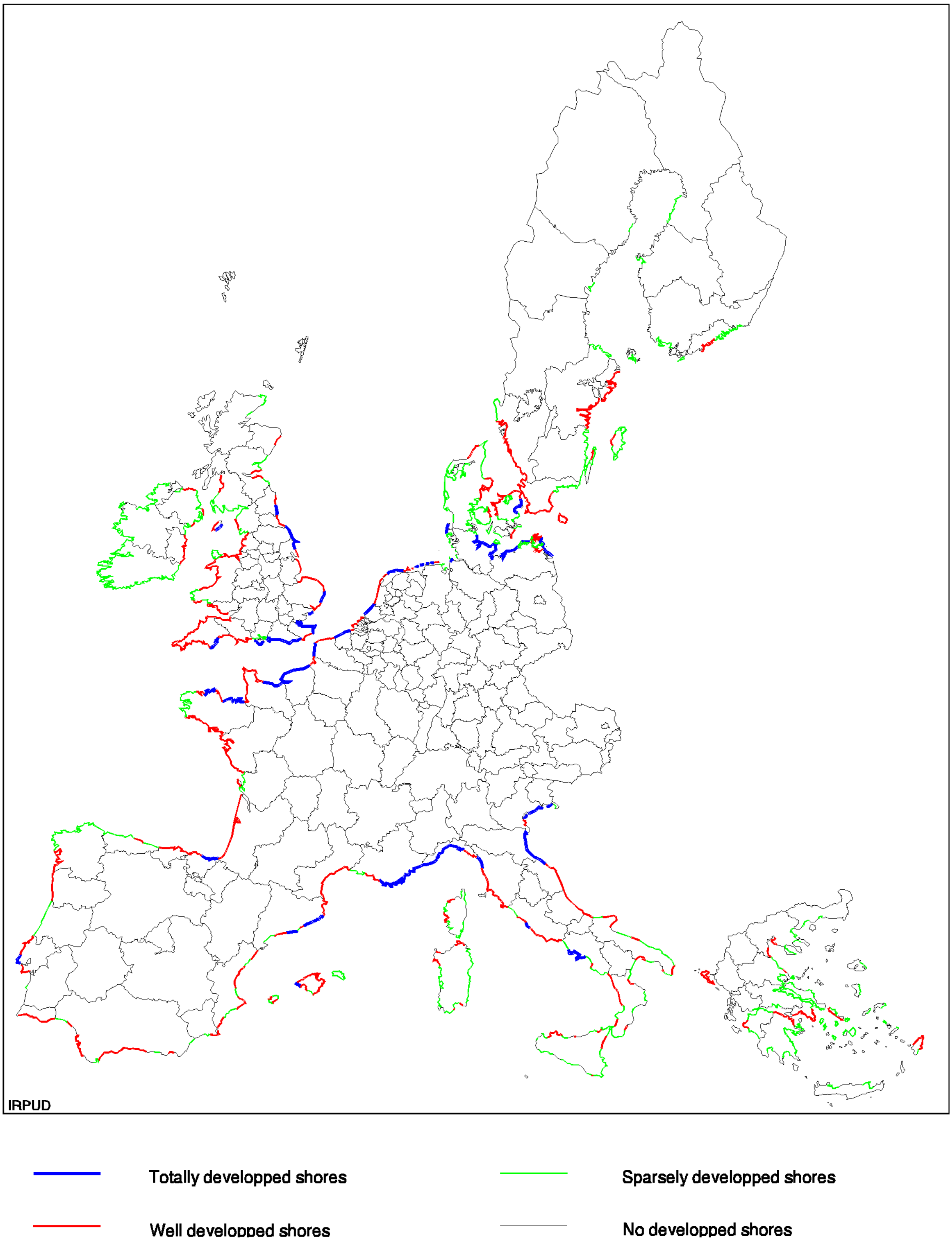


Figure 21. Development of shores *across Europe (Source: Ritter, 1966).*

4 Results

This chapter presents the results of the multi-criteria analysis based on the nine indicators for 201 European regions. First the indicator values are discussed for the three categories *climate*, *landscape* and *touristic* facilities and for the aggregated *quality of life*. Then the 201 regions are ranked according to *quality of life*.

4.1 Indicator Values

Climate

Figure 22 shows the results for *climate*. The north of Scandinavia, Scotland and Ireland obtain very low values with less than 30 points because of their low temperatures and low sunshine energy. Some Alpine regions in Austria, northern Italy and France as well as some regions in the German midlands have low or medium values between 30 and 60 points, mainly because of their high amount of rain. Very high values of more than 75 points can be observed

(a) in Central France as well as along the upper Rhine valley in France and Germany (relatively little amount of rain, medium to high radiation, medium temperatures),
(b) in the Mediterranean coastal regions in the south of France, the north of Spain and in Italy as well as the eastern coasts of Greece (high temperatures, high radiation, low amount of rain),
(c) on the Mediterranean Islands (high temperatures and high to very high radiation),
(d) in the Burgenland in Austria and the south of Spain and Portugal (high temperatures and or low amount of rain).

It is remarkable, that regions along western coasts show significantly lower results than hinterland regions or regions at eastern coasts. This effect can be found in Greece, the north-west of Spain and Portugal, England and Scotland. This may be caused by the higher amounts of rain caused by western winds.

Landscape

Figure 23 illustrates the results for *landscape*. The two relief energy indicators are obvious. Mountainous regions in Austria, Germany, France, Italy, Spain and in Scotland obtain very high values with 75 points and more. Hilly regions in Germany, Ireland, the United Kingdom and France show high values between 60 and 75 points. On the other hand, some regions with much open space obtain very high values, too, e.g. regions in the middle of Spain and the south of France.

As expected, Benelux regions (no relief energy and less open space) show very low values of less than 45 points. Not surprisingly this is also true for the three German city states Berlin, Bremen and Hamburg and for the southeast of England.

Most of the regions dominated by agriculture in France, Germany, England as well as flat regions in Scandinavia with much open space show average values between 45 and 60 points.

Touristic facilities

Figure 24 illustrates the results for the *touristic facilities* category. It becomes clear that seaside regions have a better goal achievement than hinterland regions. Almost all seaside regions (with the exception of Scandinavia and Greece) obtain values of at least 45 points. This is due to the weight of 50 for the *development of shores* indicator (see Section 2.3). Again very high values can be observed at Mediterranean shores in France, northern Spain and Italy (fully developed shores as well as areas totally affected by tourism), but also coastal regions in the south of England, in Wales and the Bretagne and Normandy gain high values of more than 60 points mainly because of the shares of developed shores and areas affected by tourism.

In comparison with coastal regions, hinterland regions in central Spain, France and Germany gain relatively low values of less then 45 points. For Spain and eastern Germany this is due to the fact that there are many areas not formed by tourism at all, whereas the regions in central France are only sparsely affected by tourism.

Very low values can be observed in Scandinavia and Scotland where there is no development of shores nor of touristic areas and where there are only a limited number of attractive towns. One might argue that the Greek islands should obtain higher values than 45 points. The reason for this low level is that they consist of several islands of which in most cases only a limited number is developed with (touristic) facilities. Most islands are not developed at all or are not even inhabited. Consequently, the average development level of the whole region is lower.

Quality of life

Finally Figure 25 illustrates the overall results of the multi-criteria analysis, i.e. the *quality of life*. Mediterranean regions of France, Italy and Spain obtain the highest values. This is mainly due to climatic conditions and of the development of *touristic facilities*.

The south of Italy has slightly lower values in comparison to the northern parts, mainly because the climate there is too extreme (too high temperatures, no rainfall). The Spanish hinterlands, dry and undeveloped, obtain medium values between 45 and 60 points, i.e. lower values in comparison with the coastal regions.

Oberbayern (Germany) obtains relatively high values between 60 and 75 points mainly because of its surface variety and the share of *open space*, while most other German regions obtain medium values between 45 and 60 points with the exception of the three city-states Berlin, Bremen and Hamburg, Brandenburg, Sachsen-Anhalt and Münster (low results in the *landscape* category). Similarly, most of the Benelux regions obtain only low values between 30 and 45 points. Again, this is caused by their flat surface, a low share of *open space* and a low level of developed *touristic facilities*.

The north of Scandinavia, Scotland and Ireland obtain the lowest values for *quality of life* because of their extreme *climate* (cold temperatures, low radiation) and because their lack of *touristic facilities*.

All these results must be seen in the context of retirement migrants. This means, the *quality of life* indicator presented here focuses on natural aspects of climate and landscape. Economic factors, cultural events or other social aspects, which contribute without doubt also very much to the *quality of life*, are not integrated in this approach because these factors are much more important to younger people than to elder ones, and, beyond this, they are included in other modules of the SASI model so that they need not to be included here as well.

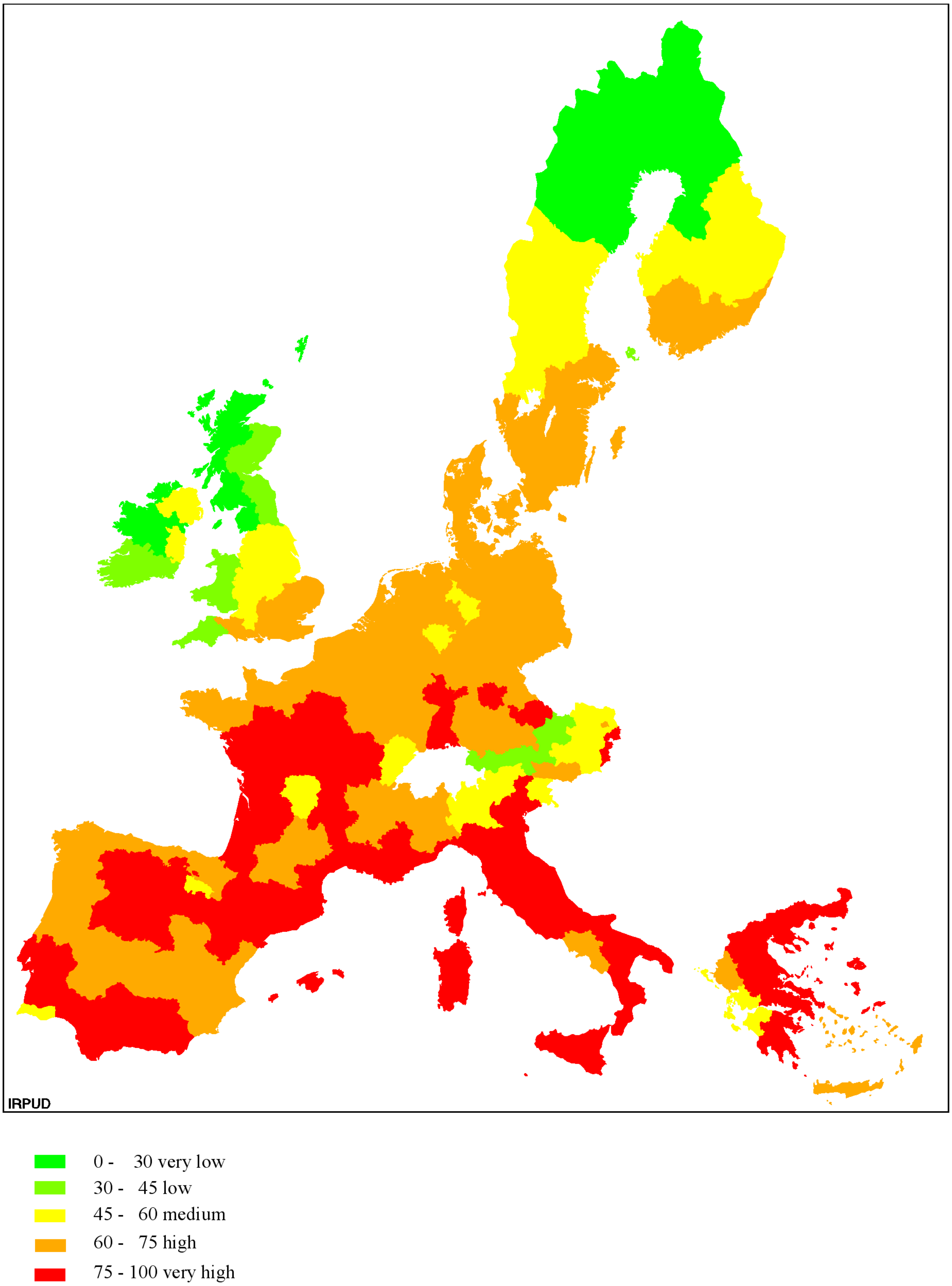
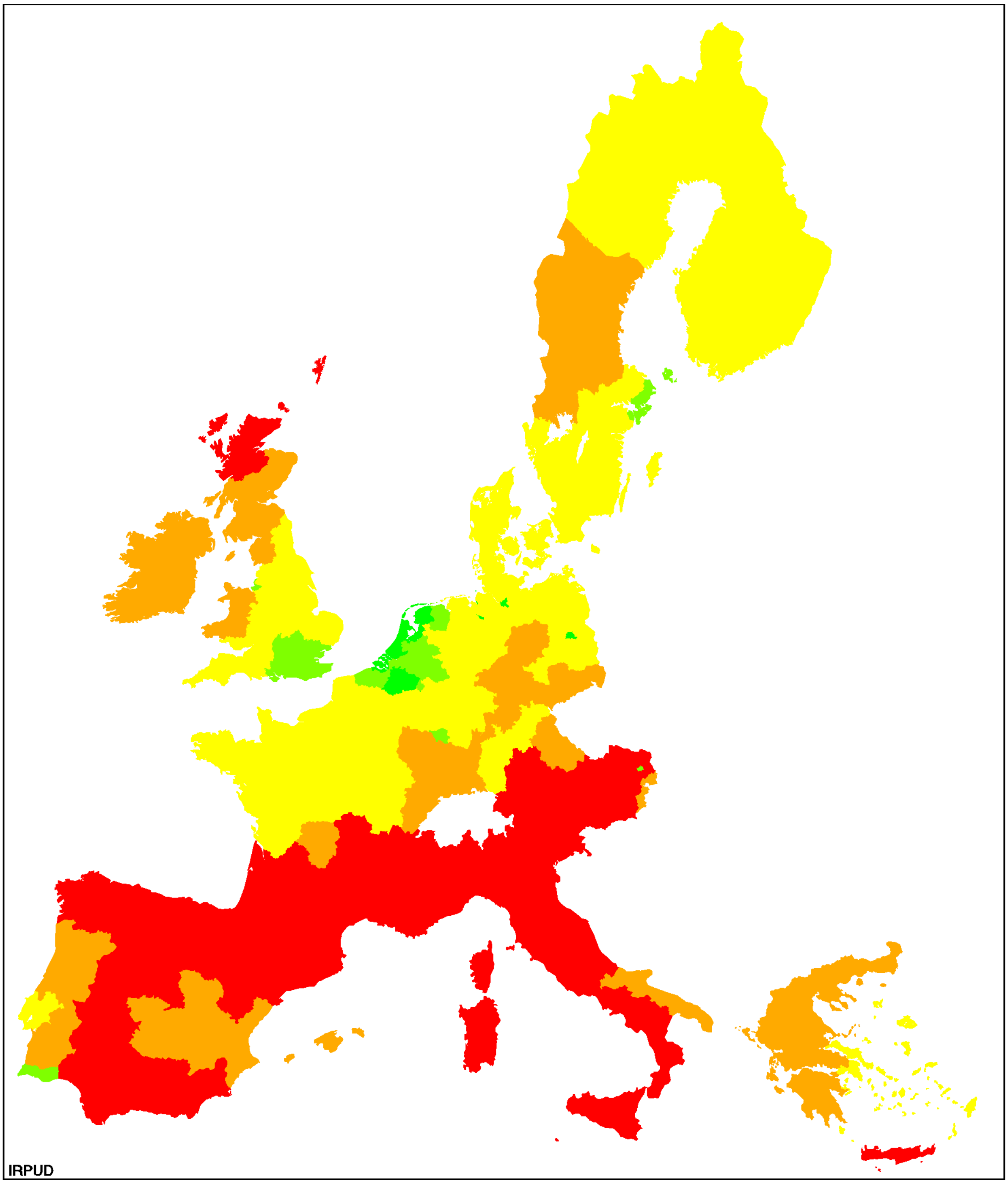
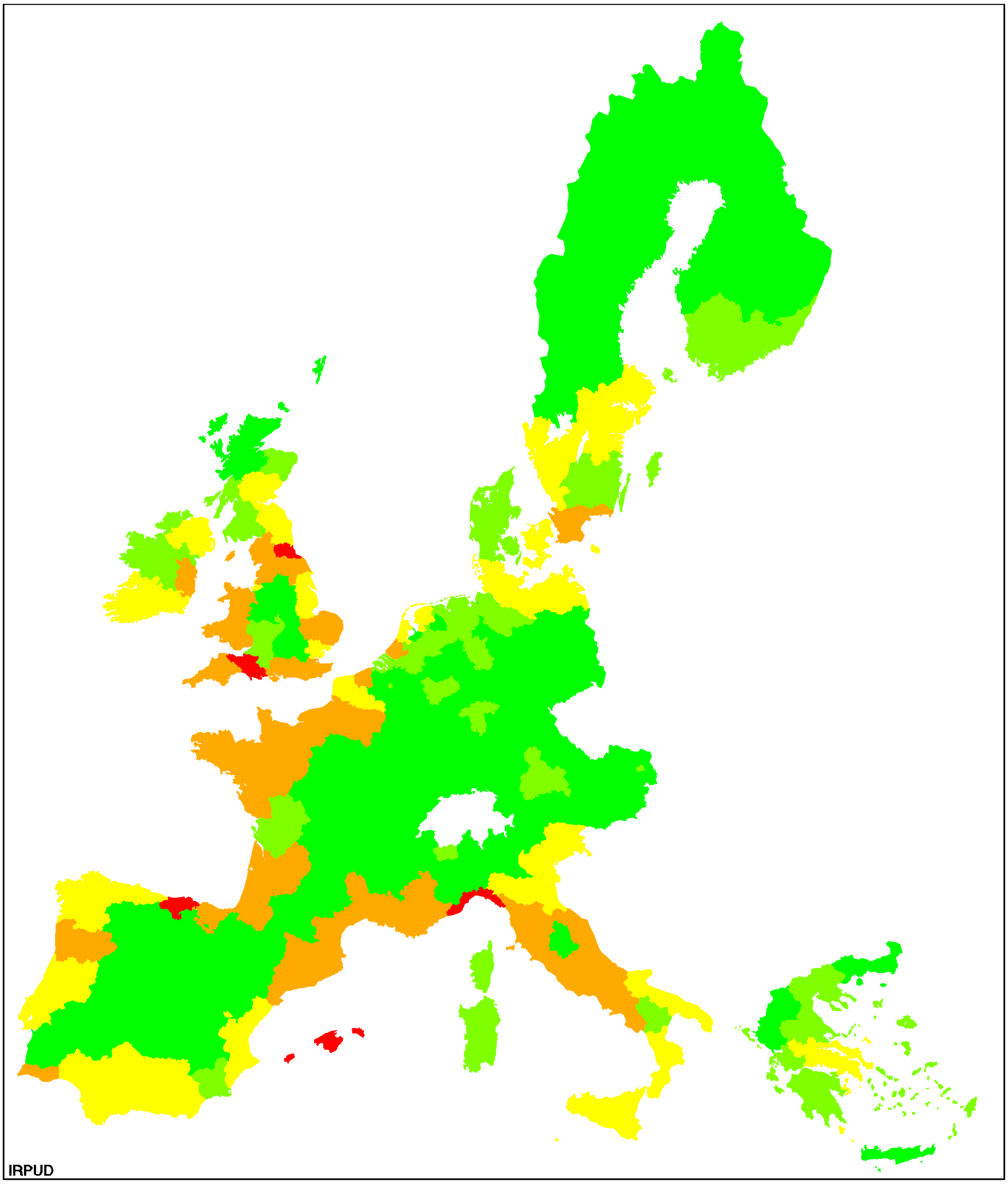


Figure 22. Spatial distribution of the climate *category.*



0 - 30 very low
30 - 45 low
45 - 60 medium
60 - 75 high
75 - 100 very high

Figure 23. Spatial distribution of the landscape *category.*



0 - 30	very low
30 - 45	low
45 - 60	medium
60 - 75	high
75 - 100	very high

Figure 24. Spatial distribution of the touristic facilities *category.*

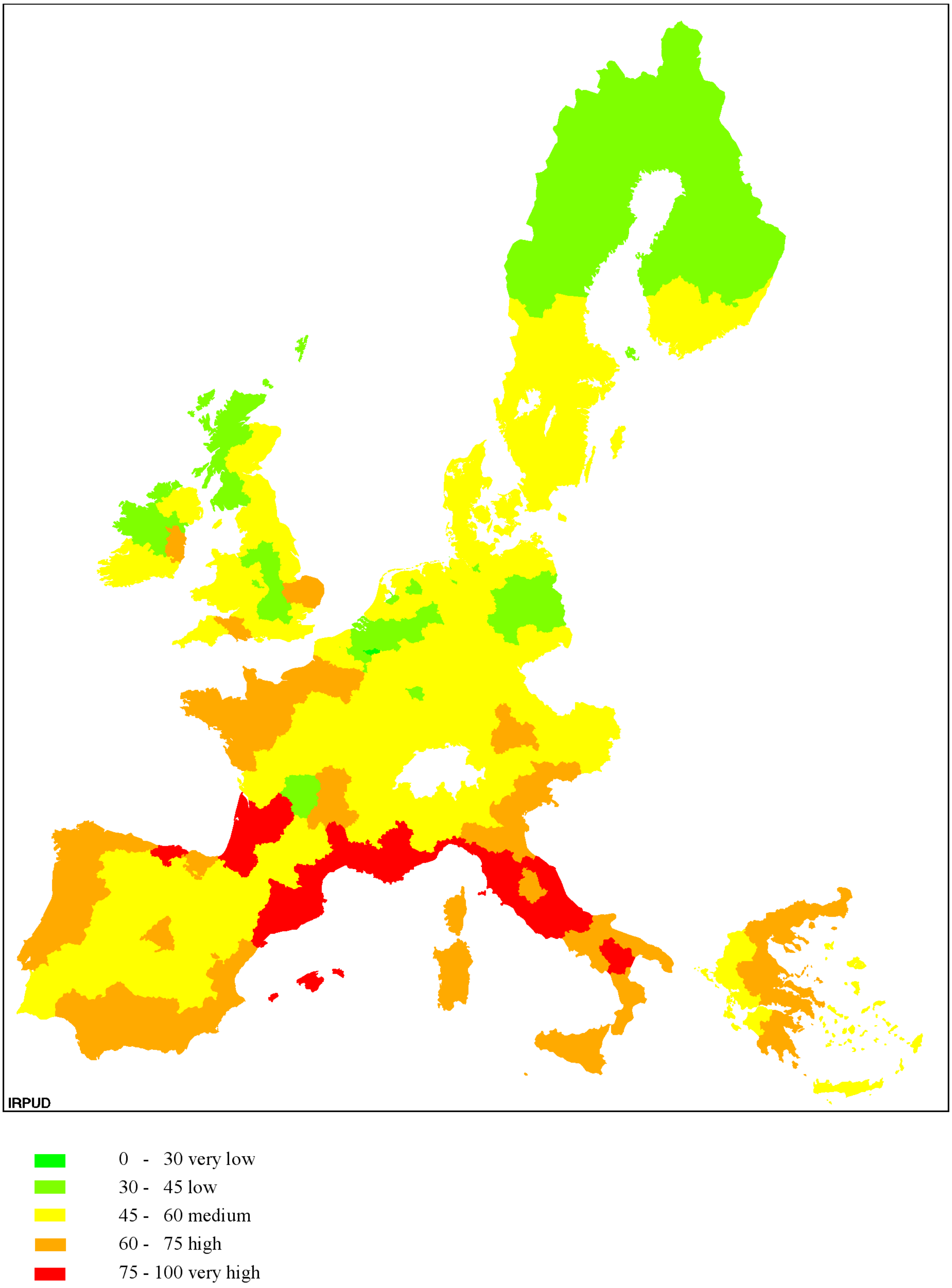


Figure 25. Spatial distribution of the quality of life *indicator.*

4.2 Ranking of Regions

Table 3 shows the ranking of regions for the *quality of life* indicator itself as well as differentiated for the three categories *climate*, *landscape* and *touristic facilities*. The regions are ordered according to the *quality of life* overall indicator.

As Figure 25 shows, Mediterranean regions in Italy, southern France and Spain obtain the highest *quality of life* values. These three countries take the first ten ranks, whereas Greek regions suffer from relatively low values for the *touristic facilities* category so that they are placed below rank 23.

The ranking for the three categories *climate*, *landscape* and *touristic facilities* is not as clear as for the overall indicator. For example, although the Islas Baleares (Spain) are placed as the eighth region for the *quality of life*, they are placed only at rank 55 for the *landscape* category. Similar differences can be observed for many regions.

Small city regions (e.g. in Germany the three city states Berlin, Bremen and Hamburg as well as Bruxelles/Brussels, Greater London and Antwerp) are placed in the lower third of the ranking mainly because of very low values for the *landscape* category. This fact demonstrates the influence of the area of regions. If these city regions included also their hinterlands, they would obtain better overall results. On the other hand, the results presented here are realistic in the sense that in reality there is a 'quality leap' between the cities themselves and their hinterlands, which is disguised in other urban regions with larger areas (e.g. Lazio, which includes Rome). Moreover, because the indicator focuses on climate and landscape and leaves cultural, social and economic aspects aside, small city regions and agglomerations such as Paris (rank 119), London (184),Brussels (193) or Berlin (199) are placed on very low ranks.

In general, Finnish regions (Pohjois-Suomi, Itä-Suomi) as well as some British regions (South and West Yorkshire, Greater Manchester) obtain low ranks because of their low performance in the *climate* and *touristic facilities* categories.

Table 3. Ranking of regions.

Region	Quality of Life *Rank (Index value)*	Categories		
		Climate *Rank (Index value)*	Landscape *Rank (Index value)*	Touristic Facilities *Rank (Index value)*
Lazio (IT)	*1 (84.23)*	7 (98.50)	25 (83.00)	6 (73.75)
Provence-Alpes-C^te d'Azure (FR)	*2 (83.57)*	7 (98.50)	33 (82.25)	9 (72.50)
CataluÁa (ES)	*3(83.33)*	1 (100.00)	9 (87.50)	27 (65.00)
Abruzzo (IT)	*4 (83.16)*	7 (98.50)	14 (86.00)	18 (67.50)
Liguria (IT)	*5 (83.00)*	14 (97.50)	42 (79.00)	4 (75.00)
Languedoc-Roussillon (FR)	*6 (81.92)*	1 (100.00)	46 (77.00)	13 (71.25)
Marche (IT)	*7 (81.68)*	7 (98.50)	21 (84.00)	27 (65.00)
Islas Baleares (ES)	*8 (80.85)*	16 (95.00)	55 (70.75)	2 (79.25)
Aquitaine (FR)	*9 (79.86)*	14 (97.50)	34 (82.00)	34 (62.50)
Toscana (IT)	*10 (78.78)*	23 (89.50)	16 (85.47)	30 (63.75)
Cantabria (ES)	*11 (77.06)*	106 (64.00)	7 (89.50)	1 (80.00)
Molise (IT)	*12 (75.41)*	1 (100.00)	61 (68.00)	37 (60.50)
Basilicata (IT)	*13 (75.15)*	1 (100.00)	12 (86.47)	77 (41.25)
Calabria (IT)	*14 (74.83)*	20 (91.00)	13 (86.25)	62 (49.50)
Emilia-Romagna (IT)	*14 (74.83)*	17 (94.00)	39 (79.75)	52 (53.00)
Corse (FR)	*16 (74.42)*	7 (98.50)	28 (82.50)	70 (44.50)
Sicilia (IT)	*17 (74.32)*	22 (90.00)	15 (85.95)	63 (49.25)
Campania (IT)	*18 (73.66)*	56 (73.00)	22 (83.95)	22 (66.25)
Veneto (IT)	*19 (73.51)*	27 (86.00)	43 (78.50)	42 (58.25)
Sardegna (IT)	*20 (72.27)*	7 (98.50)	36 (81.00)	82 (39.50)
Andalucia (ES)	*21 (70.21)*	32 (82.00)	17 (85.00)	68 (45.75)
Pais Vasco ES)	*22 (68.64)*	106 (64.00)	44 (77.75)	22 (66.25)
Sterea Ellada (GR)	*23 (67.24)*	26 (87.00)	54 (71.75)	69 (45.00)
Puglia (IT)	*24 (66.91)*	18 (92.50)	91 (60.25)	61 (50.00)
Galicia (ES)	*25 (66.25)*	106 (64.00)	38 (80.00)	43 (56.75)
Kentriki Makedonia (GR)	*26 (66.08)*	18 (92.50)	52 (74.00)	95 (33.75)
Principado de Asturias (ES)	*27 (65.75)*	106 (64.00)	26 (82.75)	53 (52.50)
Pays de la Loira (FR)	*28 (65.51)*	32 (82.00)	130 (52.75)	30 (63.75)
Lisboa e Vale do Tejo (PT)	*29 (65.18)*	25 (87.50)	106 (56.25)	51 (53.75)
Thessalia (GR)	*29 (65.18)*	20 (91.00)	50 (74.50)	98 (32.00)
Attiki (GR)	*31 (64.85)*	30 (84.00)	106 (56.25)	45 (56.25)
Dorset, Somerset (UK)	*32 (64.76)*	133 (62.25)	111 (55.25)	3 (78.75)
Comunidad Valenciana (ES)	*33 (64.73)*	52 (73.90)	75 (63.50)	39 (58.75)
Picardie (FR)	*34 (64.35)*	56 (73.00)	126 (53.25)	15 (68.75)
Dublin, Mid-East (IE)	*35 (63.69)*	167 (55.25)	72 (64.50)	7 (73.25)
Comunidad de Madrid (ES)	*36 (63.67)*	1 (100.00)	47 (75.45)	168 (17.50)
Haute-Normandie (FR)	*37 (63.61)*	48 (74.50)	126 (53.25)	27 (65.00)
Basse-Normandie (FR)	*38 (63.28)*	72 (69.25)	126 (53.25)	14 (69.25)
Bretagne (FR)	*39 (63.24)*	62 (72.25)	129 (53.20)	26 (66.20)
Anatoliki, Makedonia, Thraki (GR)	*40 (62.77)*	1 (100.00)	65 (66.97)	145 (23.25)
Umbria (IT)	*40 (62.77)*	23 (89.50)	35 (81.95)	165 (18.75)
Peloponnisos (GR)	*42 (62.36)*	34 (81.00)	59 (69.97)	91 (38.00)
Friuli-Venezia Giulia (IT)	*43 (62.12)*	156 (58.00)	39 (79.75)	60 (50.50)
East Anglia (UK)	*44 (62.04)*	91 (66.00)	149 (49.50)	9 (72.50)
Auvergne (FR)	*45 (61.30)*	31 (82.50)	48 (75.00)	107 (28.25)
Kärnten (AT)	*46 (61.22)*	146 (60.00)	2 (98.00)	113 (27.50)
Centro (PT)	*47 (61.13)*	80 (68.00)	57 (70.25)	65 (47.00)
Norte (PT)	*48 (61.05)*	139 (61.00)	85 (61.50)	34 (62.50)
Oberbayern (DE)	*49 (60.95)*	67 (70.75)	22 (83.95)	104 (30.00)
Regi\n de Murcia (ES)	*50 (60.44)*	115 (63.90)	37 (80.50)	85 (38.75)
Poitou-Charentes (FR)	*51 (59.65)*	28 (85.50)	130 (52.75)	73 (42.50)
Piemonte (IT)	*52 (59.32)*	73 (69.00)	8 (88.75)	150 (22.00)
Sydsverige (SE)	*52 (59.32)*	88 (67.00)	142 (51.00)	36 (61.75)
Trentino-Alto Adige (IT)	*54 (59.22)*	166 (55.71)	3 (96.25)	113 (27.50)
West-Vlaanderen (BE)	*55 (59.07)*	77 (68.50)	168 (44.25)	22 (66.25)
Nord-Pas-de-Calais (FR)	*56 (59.05)*	84 (67.50)	135 (52.70)	39 (58.75)
Rh^ne-Alpes (FR)	*57 (58.81)*	114 (63.96)	10 (87.25)	121 (27.00)
Midi-PyrJnJes (FR)	*58 (58.73)*	61 (72.96)	19 (84.50)	158 (20.50)
Valle d'Aosta (IT)	*59 (58.66)*	106 (64.00)	28 (82.50)	100 (31.25)
Lancashire (UK)	*60 (58.49)*	162 (56.25)	152 (49.00)	12 (72.00)

Table 3. Ranking of regions (cont.).

Region	Quality of Life *Rank (Index Value)*	Categories		
		Climate *Rank (Index value)*	Landscape *Rank (Index value)*	Touristic Facilities *Rank (Index value)*
Schwaben (DE)	*61 (58.32)*	56 (73.00)	31 (82.47)	154 (21.25)
Freiburg (DE)	*62 (57.99)*	38 (79.00)	60 (69.25)	113 (27.50)
Clwyd, Dyfed, Gwynedd, Powys (UK)	*63 (57.98)*	191 (36.75)	67 (66.45)	9 (72.50)
Kriti (GR)	*64 (57.42)*	64 (71.00)	45 (77.25)	127 (25.75)
Steiermark (AT)	*65 (57.34)*	157 (57.00)	5 (93.00)	140 (23.75)
Surrey, East-West Sussex (UK)	*66 (56.92)*	88 (67.00)	180 (38.00)	18 (67.50)
North Yorkshire (UK)	*67 (56.68)*	174 (50.75)	123 (53.50)	18 (67.50)
Västsverige (SE)	*67 (56.68)*	77 (68.50)	138 (52.00)	57 (51.25)
Schleswig-Holstein (DEF)	*67 (56.68)*	103 (64.50)	158 (48.00)	38 (59.25)
Cornwall, Devon (UK)	*70 (56.35)*	190 (38.75)	97 (58.75)	7 (73.25)
Cleveland, Durham (UK)	*71 (56.18)*	184 (41.75)	123 (53.50)	4 (75.00)
Dytiki Makedonia (GR)	*71 (56.18)*	7 (98.50)	73 (64.35)	194 (7.50)
Kent (UK)	*73 (56.10)*	106 (64.00)	182 (37.75)	17 (68.25)
Dytiki Ellada (GR)	*73 (56.10)*	155 (58.50)	53 (72.00)	82 (39.50)
Castilla y Leon (ES)	*75 (56.07)*	37 (79.90)	28 (82.50)	194 (7.50)
Aragón (ES)	*76 (55.93)*	41 (76.75)	19 (84.50)	192 (8.25)
Hovedstadtsreg., qst f. StorebFlt (DK)	*77 (55.69)*	98 (65.75)	155 (48.50)	49 (54.50)
Alentejo (PT)	*78 (55.60)*	29 (85.00)	85 (61.50)	150 (22.00)
Hamshire, Isle of Wight (UK)	*79 (55.52)*	99 (65.50)	184 (36.50)	22 (66.25)
Alsace (FR)	*79 (55.52)*	48 (74.50)	62 (67.50)	124 (26.25)
Karlsruhe (DE)	*79 (55.52)*	42 (76.00)	71 (65.00)	119 (27.25)
Mecklenburg-Vorpommern (DE)	*82 (55.39)*	137 (61.65)	146 (50.45)	46 (55.75)
Voreio Aigaio (GR)	*83 (55.36)*	36 (80.50)	119 (54.25)	96 (33.00)
Östra Mellansverige (SE)	*84 (55.27)*	80 (68.00)	130 (52.75)	66 (46.75)
SmDland med Öarna (SE)	*85 (55.03)*	73 (69.00)	104 (56.50)	77 (41.25)
Northern Island (UK)	*86 (53.95)*	179 (46.25)	90 (60.50)	43 (56.75)
Ionia Nisia (GR)	*87 (53.87)*	169 (54.50)	64 (67.00)	76 (41.75)
Salzburg (AT)	*88 (53.86)*	186 (40.75)	1 (99.95)	146 (22.50)
Stockholm (SE)	*89 (53.71)*	73 (69.00)	175 (39.50)	50 (54.25)
Zuid-Holland (NL)	*90 (53.54)*	80 (68.00)	190 (25.50)	15 (68.75)
Comunidad Foral de Navarra (ES)	*91 (53.53)*	106 (64.00)	18 (84.97)	185 (13.25)
Burgenland (AT)	*92 (53.38)*	34 (81.00)	89 (60.75)	161 (20.00)
Borders, Central, Fife, Lothian (UK)	*92 (53.38)*	188 (40.25)	68 (66.00)	47 (55.50)
Lorraine (FR)	*94 (52.80)*	48 (74.50)	66 (66.75)	165 (18.75)
Darmstadt (DE)	*95 (52.72)*	56 (73.00)	113 (55.00)	99 (31.75)
Lombardia (IT)	*96 (52.55)*	163 (56.00)	26 (82.75)	158 (20.50)
Niederbayern (DE)	*97 (52.30)*	44 (75.50)	69 (65.50)	168 (17.50)
Unterfranken (DE)	*98 (52.14)*	56 (73.00)	78 (62.50)	146 (22.50)
Cumbria (UK)	*98 (52.14)*	196 (28.75)	84 (61.75)	18 (67.50)
Gwent, Mid-South-West Glam. (UK)	*100 (52.06)*	193 (34.75)	94 (59.25)	30 (63.75)
Bourgogne (FR)	*101 (51.97)*	40 (78.50)	98 (58.50)	158 (20.50)
Notio Aigaio (GR)	*101 (51.97)*	53 (73.50)	163 (46.00)	91 (38.00)
Trier (DE)	*103 (51.81)*	64 (71.00)	96 (59.00)	121 (27.00)
Oberpfalz (DE)	*104 (51.73)*	53 (73.50)	82 (62.00)	154 (21.25)
Lincolnshire (UK)	*104 (51.73)*	164 (55.75)	150 (49.25)	56 (51.75)
Algarve (PT)	*106 (51.61)*	148 (59.90)	186 (33.25)	33 (63.25)
Mid-West, S-E, S-W (IE)	*107 (51.48)*	189 (39.75)	69 (65.50)	59 (50.75)
Koblenz (DE)	*108 (51.40)*	69 (69.75)	98 (58.50)	113 (27.50)
Vest for StorebFlt (DK)	*108 (51.40)*	116 (63.75)	152 (49.00)	72 (43.00)
Oberfranken (DE)	*110 (51.31)*	63 (72.00)	93 (59.75)	140 (23.75)
Rheinhessen-Pfalz (DE)	*111 (51.23)*	46 (75.00)	104 (56.50)	140 (23.75)
Castilla-la Mancha (ES)	*112 (51.20)*	47 (74.90)	50 (74.50)	200 (5.75)
Weser-Ems (DE)	*113 (51.15)*	116 (63.75)	136 (52.50)	85 (38.75)
Uusima (FI)	*113 (51.15)*	134 (62.00)	143 (50.50)	73 (42.50)
Kassel (DE)	*115 (50.77)*	122 (63.25)	77 (63.00)	113 (27.50)
Avon, Gloucestershire, Wiltshire (UK)	*116 (50.65)*	151 (59.25)	143 (50.50)	71 (43.75)
Merseyside (UK)	*117 (50.57)*	151 (59.25)	173 (41.50)	53 (52.50)
Northumberland, Tyne and Wear (UK)	*117 (50.57)*	183 (42.25)	137 (52.25)	39 (58.75)
Sle de France (FR)	*119 (50.49)*	42 (76.00)	157 (48.25)	107 (28.75)
Braunschweig (DE)	*120 (50.41)*	129 (62.50)	74 (64.00)	124 (26.25)

Table 3. Ranking of regions (cont.).

Region	*Quality of Life* *Rank (Index value)*	Categories: Climate *Rank (Index value)*	Categories: Landscape *Rank (Index value)*	Categories: Touristic Facilities *Rank (Index value)*
Köln (DE)	*121 (50.32)*	87 (67.25)	147 (50.25)	94 (35.00)
Grampian (UK)	*122 (50.08)*	185 (41.25)	56 (70.50)	81 (40.00)
Extremadura (ES)	*123 (50.03)*	121 (63.40)	31 (82.47)	200 (5.75)
Tirol (AT)	*124 (49.91)*	192 (35.00)	6 (92.50)	140 (23.75)
Lüneburg (DE)	*125 (49.66)*	136 (61.75)	150 (49.25)	82 (39.50)
Giessen (DE)	*125 (49.66)*	100 (65.00)	102 (56.75)	107 (28.75)
Ipeiros (GR)	*127 (49.58)*	80 (68.00)	81 (62.25)	161 (20.00)
Tübingen (DE)	*127 (49.58)*	64 (71.00)	94 (59.25)	161 (20.00)
Niederösterreich (AT)	*127 (49.58)*	175 (50.00)	41 (79.50)	157 (20.75)
Luxembourg (LU)	*130 (49.42)*	70 (69.50)	115 (54.75)	128 (25.50)
Stuttgart (DE)	*130 (49.42)*	77 (68.50)	106 (56.25)	129 (25.00)
Luxembourg (BE)	*132 (49.24)*	70 (69.50)	118 (54.70)	129 (25.00)
Detmold (DE)	*133 (49.17)*	139 (61.00)	101 (57.00)	102 (31.00)
Humberside (UK)	*134 (49.17)*	170 (53.75)	163 (46.00)	64 (49.25)
Centre (FR)	*135 (49.09)*	38 (79.00)	130 (52.75)	174 (17.00)
Voralberg (AT)	*136 (49.00)*	195 (33.00)	4 (93.75)	153 (21.75)
Liege (BE)	*137 (48.78)*	84 (67.50)	130 (52.75)	113 (27.50)
La Rioja (ES)	*138 (48.59)*	176 (49.75)	24 (83.75)	182 (13.75)
Essex (UK)	*139 (48.51)*	100 (65.00)	185 (35.75)	67 (46.25)
Wien (AT)	*140 (48.42)*	48 (74.50)	174 (39.75)	97 (32.50)
Namur (BE)	*141 (48.18)*	84 (67.50)	123 (53.50)	129 (25.00)
Mittelfranken (DE)	*142 (48.10)*	45 (75.25)	115 (54.75)	178 (15.75)
Hereford & Worcester (UK)	*142 (48.10)*	153 (58.75)	110 (55.75)	100 (31.25)
Oberösterreich (AT)	*144 (48.01)*	193 (34.75)	11 (86.50)	138 (24.25)
Overijssel (NL)	*145 (47.85)*	142 (60.75)	165 (45.50)	85 (38.75)
Sachsen (DE)	*146 (47.68)*	91 (66.00)	88 (61.00)	168 (17.50)
Norra Mellansverige (SE)	*147 (47.67)*	149 (59.75)	76 (63.45)	154 (21.25)
Utrecht (NL)	*148 (47.52)*	91 (66.00)	176 (39.25)	85 (38.75)
Thüringen (DE)	*149 (47.19)*	124 (63.00)	78 (62.50)	168 (17.50)
Champagne-Ardenne (FR)	*150 (47.02)*	53 (73.50)	115 (54.75)	181 (14.25)
Gelderland (NL)	*150 (47.02)*	142 (60.75)	171 (43.00)	85 (38.75)
Noord-Holland (NL)	*152 (46.78)*	68 (70.00)	195 (19.25)	53 (52.50)
Etelä-Suomi (FI)	*153 (46.61)*	146 (60.00)	140 (51.25)	104 (30.00)
Arnsberg (DE)	*154 (46.36)*	157 (57.00)	106 (56.25)	119 (27.25)
Franche-Comté (FR)	*155 (46.03)*	173 (52.00)	58(70.00)	168 (17.50)
Shropshire, Staffordshire (UK)	*155 (46.03)*	160 (56.75)	122 (54.00)	107 (28.75)
Friesland (NL)	*157(45.87)*	102 (64.75)	194 (23.00)	57 (51.25)
Hannover (DE)	*158 (45.62)*	153 (58.75)	111 (55.25)	138 (24.25)
Groningen (NL)	*159 (45.13)*	116 (63.75)	186 (34.25)	85 (38.75)
Derbyshire, Nottinghamshire (UK)	*160 (44.88)*	172 (52.75)	100 (58.25)	129 (25.00)
Limousin (FR)	*160 (44.88)*	157 (57.00)	82 (62.00)	174 (17.00)
Noord-Brabant (NL4)	*162 (44.47)*	124 (63.00)	172 (41.75)	104 (30.00)
Saarland (DE)	*163 (44.05)*	90 (66.50)	167 (44.50)	146 (22.50)
Magdeburg (DE)	*164 (43.68)*	137 (61.65)	80 (62.45)	192 (8.25)
Mellersta Norrland (SE)	*165 (43.23)*	180 (45.75)	85 (61.50)	143 (23.75)
Zeeland (NL)	*166 (43.15)*	73 (69.00)	192 (24.25)	93 (37.50)
Leicesterhsire, Northamptonshire (UK)	*167 (42.90)*	160 (56.75)	154 (48.50)	136 (24.75)
Limburg (NL)	*167 (42.90)*	91 (66.00)	178 (39.25)	136 (24.75)
Drenthe (NL)	*167 (42.90)*	142 (60.75)	168 (44.25)	129 (25.00)
Hamburg (DE)	*170 (42.65)*	116 (63.75)	198 (10.50)	48 (55.00)
Berkshire, Buckinghamshire (UK)	*170 (42.65)*	91 (66.00)	179 (38.25)	129 (25.00)
Halle (DE)	*172 (42.62)*	130 (62.40)	119 (54.25)	188 (12.50)
Bedforshire, Hertfordshire (UK)	*173 (42.57)*	91 (66.00)	180 (38.00)	129 (25.00)
Hainaut (BE)	*174 (41.99)*	103 (64.50)	162 (46.50)	177 (16.25)
Dumfires, Galloway, Strathclyde (UK)	*175 (41.83)*	198 (18.75)	62 (67.50)	80 (40.50)
Border, Midland-West (IE)	*176 (41.66)*	197 (23.75)	92 (60.00)	73 (42.50)
Brandenburg (DE)	*177 (41.63)*	130 (62.40)	143 (50.50)	186 (13.25)
Münster (DE)	*178 (41.50)*	128 (62.75)	158 (48.00)	179 (15.00)
Dessau (DE)	*179 (41.22)*	130 (62.40)	158 (48.00)	180 (14.50)
Väli-Suomi (FI)	*180 (39.68)*	180 (45.75)	138 (52.00)	146 (22.50)

Table 3. Ranking of regions (cont.).

Region	Quality of Life *Rank (Index value)*	Categories: Climate *Rank (Index value)*	Categories: Landscape *Rank (Index value)*	Categories: Touristic Facilities *Rank (Index value)*
Cheshire (UK)	*181 (39.10)*	167 (55.25)	166 (45.25)	167 (18.00)
Highlands, Islands (UK)	*182 (38.94)*	201 (14.75)	48 (75.00)	107 (28.25)
Ahvenanmaa/Cland (FI)	*183 (38.83)*	187 (40.65)	170 (43.50)	103 (30.50)
Greater London (UK)	*184 (37.70)*	134 (62.00)	178 (38.50)	184 (13.75)
Düsseldorf (DE)	*185 (36.96)*	116 (63.75)	182 (37.75)	190 (10.50)
West Midlands (UK)	*186 (36.71)*	164 (55.75)	154 (48.50)	196 (7.00)
West Yorkshire (UK)	*187 (36.05)*	177 (49.25)	140 (51.25)	191 (8.75)
Oost-Vlaanderen (BE)	*187 (36.05)*	124 (63.00)	188 (33.00)	185 (13.25)
Limburg (BE)	*189 (35.97)*	91 (66.00)	189 (29.25)	182 (13.75)
Greater Manchester (UK)	*190 (35.39)*	171 (53.25)	161 (47.75)	197 (6.25)
Flevoland (NL)	*191 (35.06)*	142 (60.75)	190 (25.50)	161 (20.00)
Itä-Suomi (FI)	*192 (35.05)*	180 (45.75)	121 (54.20)	197 (6.25)
Bruxelles/Brussle (BE)	*193 (34.57)*	124 (63.00)	201 (0.50)	77 (41.25)
South Yorkshire (UK)	*194 (34.40)*	178 (48.25)	148 (49.75)	197 (6.25)
Antwerpen (BE)	*195 (33.74)*	139 (61.00)	192 (24.25)	174 (17.00)
Vlaams Brabant (BE)	*196 (33.25)*	106 (64.00)	195 (19.25)	168 (17.50)
Pohjois-Suomi (FI)	*197 (32.97)*	199 (16.65)	113 (55.00)	107 (28.25)
Bremen (DE)	*198 (32.50)*	149 (59.75)	197 (11.75)	121 (27.00)
Berlin (DE)	*199 (32.14)*	123 (63.15)	200 (8.00)	124 (26.25)
Övre Norrland (SE)	*200 (31.48)*	199 (16.65)	102 (56.75)	150 (22.00)
Brabant Wallon (BE)	*201 (28.21)*	103 (64.50)	199 (8.50)	188 (12.50)

5 Conclusions

The evaluation of the *quality of life* of European regions presented here can serve as an endowment indicator to be included in quantitative methods, such as population forecasting models or migration models or when natural qualities of regions are to be measured or compared. The indicator is sensitive to different starting points and therefore is able to differentiate and rank regions according to their attractiveness. As a result of the multi-criteria analysis, there is one indicator value for each region. The higher the attractiveness, the higher this value. In general, the applicability is not limited to a certain field.

As a first application in the SASI project (in which this indicator originated) the *quality of life* indicator is included into a net migration forecast model. There the indicator is included into a regression equation as one of several explanatory variables (Wegener and Bökemann, 1998). Other variables are natural population change and regional unemployment rate.

This indicator of *quality of life* does not include social aspects such as crime, unemployment or health which without doubt contribute very much to the *quality of life* in cities or metropolitan areas. However, in the SASI project these aspects are considered in other submodels. Findlay *et al.* (1988b) and QOLNET (1999) give comprehensive overviews of similar studies on the assessment of *quality of life* in cities. These studies contain several social indicators ranging from various crime rates to the cost of private rented housing.

It is also possible to include the *quality of life* indicator into gravitational approaches for estimating relationships between two or more regions. In this case, the regions are interpreted as origins or destinations and the indicator values as weights on the destinations, as it is done in transport models or when estimating tourist flows. So the interaction between two (or more) regions can be computed.

The *quality of life* presented here needs not to be confined on a regional level. The indicator structure can be applied at a spatially more disaggregate or at a spatially more aggregate level. The rule is that the smaller the regions are, the more differentiated the results will be, i.e. the inter- and intraregional differences. For example, if the spatial level in this approach were further disaggregated below the regions used in this approach, the coastal Mediterranean regions with the highest *quality of life* values would be divided into subregions along the coastline with highest values and subregions some distance away from the coast with lower values. Furthermore, slopes in the Alps oriented towards the south would gain higher values than those oriented towards the north. It is only a small step to disaggregate the spatial resolution. The system of region chosen for this approach is the one required by the SASI project, but spatial refinement at every intermediate step is possible.

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7 Technical Annex

The technical annex is addressed to ARC/INFO users and programmers, who would like to duplicate the *quality of life* indicator. The annex describes the implementation of the multi-criteria analyses in ARC/INFO. It focuses on data management (A.1 and A.2), the transformation of the mapping functions into the program (A.3) and the structure of the developed AML macro (A.4). The source code of the program is listed in A.5.

A.1 System of Regions

The spatial units on which the multi-criteria analysis is based are NUTS-2 regions defined by Eurostat (1995). Table A1 shows the system of regions used. The first column indicates the country, the second column the internal region number, the third column the name of the region, the fourth column the official NUTS-2 region code as it is defined by Eurostat (1995), and the last column gives the centroid of the region, usually the main city in the region.

Table A1. The system of regions used.

Country	No	Region name	NUTS 1995 or equivalent code	Centroid
Österreich	1	Burgenland	AT11	Eisenstadt
	2	Niederösterreich	AT12	St.Pölten
	3	Wien	AT13	Wien
	4	Kärnten	AT21	Klagenfurt
	5	Steiermark	AT22	Graz
	6	Oberösterreich	AT31	Linz
	7	Salzburg	AT32	Salzburg
	8	Tirol	AT33	Innsbruck
	9	Vorarlberg	AT34	Dornbirn
Belgique / België	10	Bruxelles / Brussel	BE1	Bruxelles / Brussel
	11	Antwerpen	BE21	Antwerpen
	12	Limburg (BE)	BE22	Hasselt
	13	Oost-Vlaanderen	BE23	Gent
	14	Vlaams Brabant	BE24	Leuven
	15	West-Vlaanderen	BE25	Brugge
	16	Brabant Wallon	BE31	Wavre
	17	Hainaut	BE32	Charleroi
	18	Liege	BE33	Liege
	19	Luxembourg (BE)	BE34	Arlon
	20	Namur	BE35	Namur
Deutschland	21	Stuttgart	DE11	Stuttgart
	22	Karlsruhe	DE12	Mannheim
	23	Freiburg	DE13	Freiburg im Breisgau
	24	Tübingen	DE14	Tübingen
	25	Oberbayern	DE21	München
	26	Niederbayern	DE22	Landshut
	27	Oberpfalz	DE23	Regensburg
	28	Oberfranken	DE24	Bamberg
	29	Mittelfranken	DE25	Nürnberg
	30	Unterfranken	DE26	Würzburg
	31	Schwaben	DE27	Augsburg
	32	Berlin	DE3	Berlin

Table A1. The system of regions used (cont.).

Country	No.	Region name	NUTS 1995 or equivalent code	Centroid
Deutschland (cont.)	33	Brandenburg	DE4	Potsdam
	34	Bremen	DE5	Bremen
	35	Hamburg	DE6	Hamburg
	36	Darmstadt	DE71	Frankfurt am Main
	37	Giessen	DE72	Giessen
	38	Kassel	DE73	Kassel
	39	Mecklenburg-Vorpommern	DE8	Rostock
	40	Braunschweig	DE91	Braunschweig
	41	Hannover	DE92	Hannover
	42	Lüneburg	DE93	Lüneburg
	43	Weser-Ems	DE94	Oldenburg
	44	Düsseldorf	DEA1	Düsseldorf
	45	Köln	DEA2	Köln
	46	Münster	DEA3	Münster
	47	Detmold	DEA4	Bielefeld
	48	Arnsberg	DEA5	Dortmund
	49	Koblenz	DEB1	Koblenz
	50	Trier	DEB2	Trier
	51	Rheinhessen-Pfalz	DEB3	Mainz
	52	Saarland	DEC	Saarbrücken
	53	Sachsen	DED	Leipzig
	54	Dessau	DEE1	Dessau
	55	Halle	DEE2	Halle
	56	Magdeburg	DEE3	Magdeburg
	57	Schleswig-Holstein	DEF	Kiel
	58	Thüringen	DEG	Erfurt
Danmark	59	Vest for Storebælt	DK11 (DK001-7)	København
	60	Hovedstadtsregionen and Øst for Storebælt	DK12 (DK008-F)	Arhus
España	61	Galicia	ES11	Santiago
	62	Principado de Asturias	ES12	Oviedo
	63	Cantabria	ES13	Santander
	64	Pais Vasco	ES21	Bilbao
	65	Comunidad Foral de Navarra	ES22	Pamplona
	66	La Rioja	ES23	Logrono
	67	Aragón	ES24	Zaragoza
	68	Comunidad de Madrid	ES3	Madrid
	69	Castilla y Leon	ES41	Valladolid
	70	Castilla-la Mancha	ES42	Toledo
	71	Extremadura	ES43	Mérida
	72	Cataluña	ES51	Barcelona
	73	Comunidad Valenciana	ES52	Valencia
	74	Islas Baleares	ES53	Palma de Mallorca
	75	Andalucia	ES61	Sevilla
	76	Región de Murcia	ES62	Murcia
Suomi / Finland	77	Uusimaa	FI11	Helsinki
	78	Etelä-Suomi	FI12	Tampere
	79	Itä-Suomi	FI13	Kuopio
	80	Väli-Suomi	FI14	Jyväskylä
	81	Pohjois-Suomi	FI15	Oulu
	82	Ahvenanmaa / Åland	FI2	Maarianhamina
France	83	Île de France	FR1	Paris
	84	Champagne-Ardenne	FR21	Reims
	85	Picardie	FR22	Amiens
	86	Haute-Normandie	FR23	Le Havre
	87	Centre	FR24	Orleans
	88	Basse-Normandie	FR25	Caen
	89	Bourgogne	FR26	Dijon
	90	Nord-Pas-de-Calais	FR3	Lille
	91	Lorraine	FR41	Metz
	92	Alsace	FR42	Strasbourg

Table A1. The system of regions used (cont.).

Country	No.	Region name	NUTS 1995 or equivalent code	Country
France (cont.)	93	Franche-Comté	FR43	Besancon
	94	Pays de la Loire	FR51	Nantes
	95	Bretagne	FR52	Brest
	96	Poitou-Charentes	FR53	Poitiers
	97	Aquitaine	FR61	Bordeaux
	98	Midi-Pyrénées	FR62	Toulouse
	99	Limousin	FR63	Limoges
	100	Rhône-Alpes	FR71	Lyon
	101	Auvergne	FR72	Clermont-Ferrand
	102	Languedoc-Roussillon	FR81	Montpellier
	103	Provence-Alpes-Côte d`Azur	FR82	Marseille
	104	Corse	FR83	Ajaccio
Ellada	105	Anatoliki Makedonia, Thraki	GR11	Kavala
	106	Kentriki Makedonia	GR12	Thessaloniki
	107	Dytiki Makedonia	GR13	Kozani
	108	Thessalia	GR14	Larissa
	109	Ipeiros	GR21	Ioannina
	110	Ionia Nisia	GR22	Kerkyra
	111	Dytiki Ellada	GR23	Patrai
	112	Sterea Ellada	GR24	Lamia
	113	Peloponnisos	GR25	Tripolis
	114	Attiki	GR3	Athinai
	115	Voreio Aigaio	GR41	Mytilini
	116	Notio Aigaio	GR42	Ermoupolis
	117	Kriti	GR43	Irakleion
Ireland	118	Dublin, Mid-East	IE11 (IE002-3)	Dublin
	119	Border, Midland-West	IE12 (IE001, IE004, IE008)	Galway
	120	Mid-West, South-East, South-West	IE13 (IE005-7)	Cork
Italia	121	Piemonte	IT11	Torino
	122	Valle d'Aosta	IT12	Aosta
	123	Liguria	IT13	Genova
	124	Lombardia	IT2	Milano
	125	Trentino-Alto Adige	IT31	Bolzano
	126	Veneto	IT32	Venezia
	127	Friuli-Venezia Giulia	IT33	Trieste
	128	Emilia-Romagna	IT4	Bologna
	129	Toscana	IT51	Firenze
	130	Umbria	IT52	Perugia
	131	Marche	IT53	Ancona
	132	Lazio	IT6	Roma
	133	Abruzzo	IT71	Pescara
	134	Molise	IT72	Campobasso
	135	Campania	IT8	Napoli
	136	Puglia	IT91	Bari
	137	Basilicata	IT92	Potenza
	138	Calabria	IT93	Reggio
	139	Sicilia	ITA	Palermo
	140	Sardegna	ITB	Cagliari
Luxembourg	141	Luxembourg	LU	Luxembourg
Nederlands	142	Groningen	NL11	Groningen
	143	Friesland	NL12	Leeuwarden
	144	Drenthe	NL13	Emmen
	145	Overijssel	NL21	Enschede
	146	Gelderland	NL22	Apeldoorn
	147	Flevoland	NL23	Lelystad
	148	Utrecht	NL31	Utrecht
	149	Noord-Holland	NL32	Amsterdam
	150	Zuid-Holland	NL33	Rotterdam

Table A1. The system of regions used (cont.).

Country	No.	Region name	NUTS 1995 or equivalent code	Country
Netherlands (cont.)	151	Zeeland	NL34	Middelburg
	152	Noord-Brabant	NL41	Eindhoven
	153	Limburg (NL)	NL42	Maastricht
Portugal	154	Norte	PT11	Porto
	155	Centro (PT)	PT12	Coimbra
	156	Lisboa e Vale do Tejo	PT13	Lisboa
	157	Alentejo	PT14	Evora
	158	Algarve	PT15	Faro
Sverige	159	Stockholm	SE01	Stockholm
	160	Östra Mellansverige	SE02	Uppsala
	161	Småland med Öarna	SE03	Jönköping
	162	Sydsverige	SE04	Malmö
	163	Västsverige	SE05	Göteborg
	164	Norra Mellansverige	SE06	Gävle
	165	Mellersta Norrland	SE07	Sundsvall
	166	Övre Norrland	SE08	Umea
United Kingdom	167	Cleveland, Durham	UK11	Middlesbrough
	168	Cumbria	UK12	Carlisle
	169	Northumberland, Tyne and Wear	UK13	Newcastle upon Tyne
	170	Humberside	UK21	Kingston upon Hull
	171	North Yorkshire	UK22	Harrogate
	172	South Yorkshire	UK23	Sheffield
	173	West Yorkshire	UK24	Leeds
	174	Derbyshire, Nottinghamshire	UK31	Nottingham
	175	Leicestershire, Northamptonshire	UK32	Leicester
	176	Lincolnshire	UK33	Lincoln
	177	East Anglia	UK4	Cambridge
	178	Bedfordshire, Hertfordshire	UK51	Luton
	179	Berkshire, Buckinghamshire, Oxfordshire	UK52	Reading
	180	Surrey, East-West Sussex	UK53	Brigthon
	181	Essex	UK54	Southend-On-Sea
	182	Greater London	UK55	London
	183	Hampshire, Isle of Wight	UK56	Southampton
	184	Kent	UK57	Maidstone
	185	Avon, Gloucestershire, Wiltshire	UK61	Bristol
	186	Cornwall, Devon	UK62	Plymouth
	187	Dorset, Somerset	UK63	Bournemouth
	188	Hereford & Worcester, Warwickshire	UK71	Warwick
	189	Shropshire, Staffordshire	UK72	Newcastle-under-Lyme
	190	West Midlands (County)	UK73	Birmingham
	191	Cheshire	UK81	Warrington
	192	Greater Manchester	UK82	Manchester
	193	Lancashire	UK83	Blackpool
	194	Merseyside	UK84	Liverpool
	195	Clwyd, Dyfed, Gwynedd, Powys	UK91	Wrexham Maelor
	196	Gwent, Mid-South-West Glamorgan	UK92	Cardiff
	197	Borders, Central, Fife, Lothian, Tayside	UKA1	Edinburgh
	198	Dumfries & Galloway, Strathclyde	UKA2	Glasgow
	199	Highlands, Islands	UKA3	Inverness
	200	Grampian	UKA4	Aberdeen
	201	Northern Ireland	UKB	Belfast

Figure 26 illustrates the system of regions used.

Figure 26. The system of regions.

A.2 Data Collection

Because the multi-criteria analysis is implemented in ARC/INFO, all indicators have to be transformed into the geographical database. All operations are performed for the system of regions (see A.1). There are three possibilities to transform and prepare indicator values for the GIS:

1. Direct, manual input via database entries into the *REGIONS coverage*, i.e. entering one value for each region. This is done for the indicators *temperature*, *rainfall* and *open space.*
2. Digitisation, i.e. generation of a single coverage for an indicator. This means that several different values can occur in one region. This method is used for the indicators *sunshine* and *attractive towns*.
3. Indicator values are obtained from previous digitisation by using generation functions (i) or specific GIS calculations (ii). This is done for the indicators *slope gradient* (ii), *elevation difference* (ii), *touristic area* (i) and *development of shores* (i).

For cases 2 and 3 regional averages weighted by area or total shore length are calculated after digitisation.

After generation of the spatial database, the different coverages are integrated into one coverage by using the ARC/INFO **`identity`** command. The multi-criteria analysis is then applied to the resulting regional database.

A.3 Utility Assignment and Weighting

The main components of multi-criteria analysis are mapping and weighting functions. Mapping functions transform observed or generated indicator values into utility values, whereas weighting functions define indicator weights in the process of utility aggregation.

Within the ARC/INFO macro language (AML) there are two possibilities to implement mapping functions. In the first case equations for each function are directly included in the source code. In the second case so-called 'lookup tables' are used. The second possibility is very useful where mapping functions are divided into several sections and where straight lines within each section can be assumed, i.e. within one section a linear correlation between observed values and utilities can be assumed. In this approach the second method is applied.

In ARC/INFO a lookup table is a special kind of data file used to categorise item values. Each category has an item value for another item. When a value for a specified indicator is entered, ARC/INFO will look for a match in the lookup table. This is straightforward as long as the mapping functions are not increasing or decreasing. In that case the mapping function is split into several equidistant intervals and the increase (decrease) in utility is equally allocated to the intervals. By this way the mapping function is transformed into a stepwise function with small increments.

For example, Figure 27 shows the principle of transferring mapping functions into lookup tables for the *rainfall* indicator.

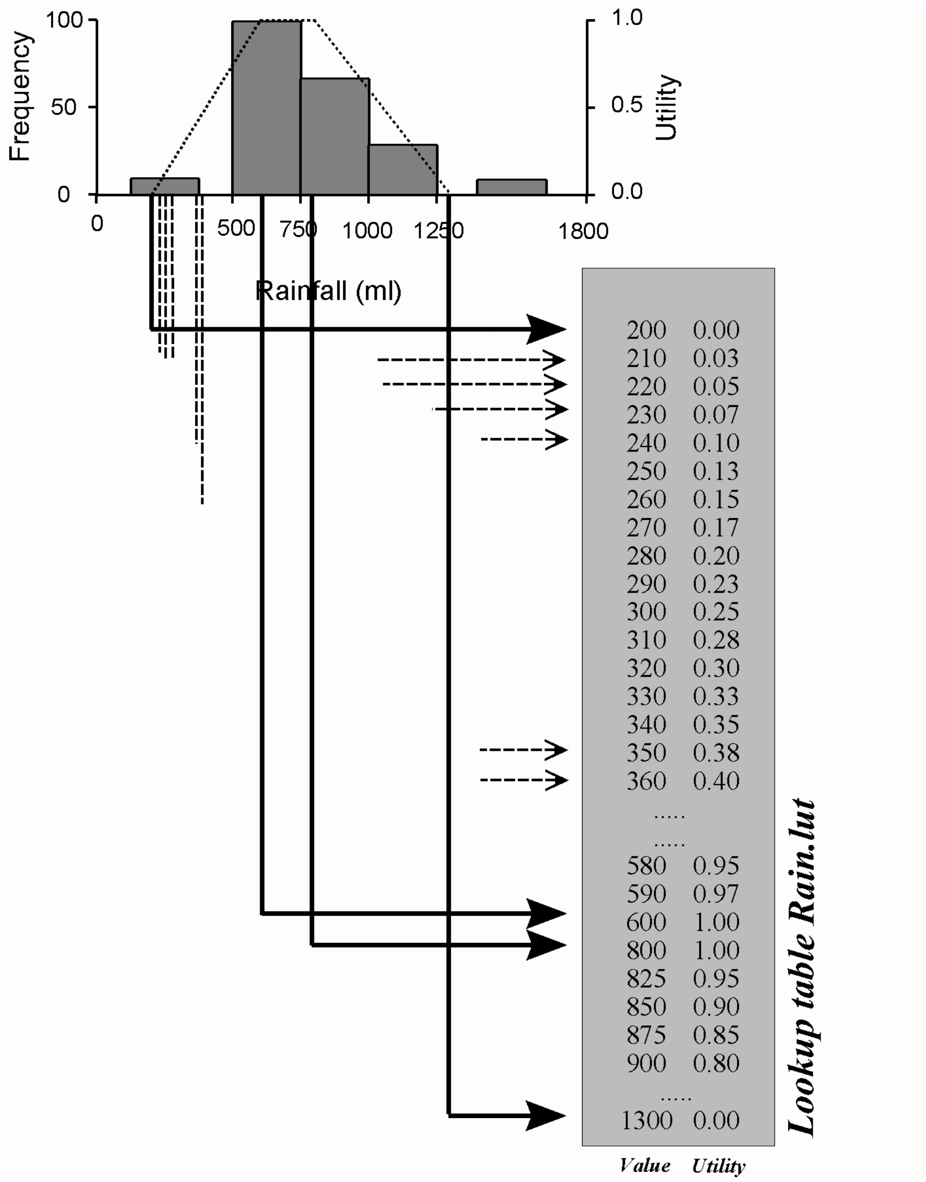

Figure 27. Transferring mapping functions into lookup tables.

The following principles have to be followed:
- Each lookup table assigns utilities for one indicator only. This means that in total nine lookup tables had to be defined prior to performing the multi-criteria analysis.
- Each lookup table consists of two columns. The first column contains the indicator values, the second column the utilities.

- The number of rows is not limited and depends on the precision required, i.e. how exact the stepwise function is to cover the increasing (decreasing) mapping function.
- The indicator values must be in ascending order.

The advantage of lookup tables, compared with equations, is that no extra source code in the AML is required, because the utilities assignment is done simply by using the **`lookup`** command in ArcEdit. This speeds up computation. Changes in the mapping functions can easily be managed without changing the AML source code.

The indicator and category weights are based on expert rankings and are directly included into the AML source code (see A.4 and A.5). They are adjusted by changing the source code.

A.4 Program Structure

The program developed to perform the multi-criteria analysis is written in the ARC/INFO macro language (AML) and consists of 114 statement lines. Only 54 statements perform the analysis as such and the remaining 60 code lines are included to create plots for presenting results.

The structure of the first 54 code lines is straight forward. The AML requires two arguments (see Statement 1 of the source code): The name of the input coverage which is the coverage created with the **`identity`** command (see A.2), and the name of the output coverage which will be automatically created and contain the results.

The first eight statements define the work environment and check whether input and output coverages as well as output graphic files exist. Statements 9 to 12 check the existence of the lookup tables. If one of these does not exist, the program is terminated.

Program Statements 13 to 18 perform the generation functions of the *touristic area* indicator (‘meantourism‘) and of the *development of shores* indicator (‘beach’). If necessary, the two generation functions can be adjusted in Statements 15 and 17, respectively.

Because regions (see A1) might consist of several separate polygons, the input coverage has to be transformed into a 'region' coverage, where each region is defined as a collection of several polygons representing the same attributes. By using the ARC/INFO **`regionquery`** command the new output region layer will be generated in Statement lines 19 to 30. Non-EU member states are dropped from further processing.

After the generation of the output region coverage, new items are added to the region attribute table (Statement numbers 31 to 33) which later (intermediate) results will be stored in.

Statement numbers 34 to 46 calculate the utility values using the lookup tables, which are produced beforehand (see A.3).

After calculating utility values for all nine indicators, the final step is the calculation of utility values for each of the three categories and the total utility, i.e. the *quality of life* indicator. This is done in Statement numbers 47 to 54. The weights of the indicators and of the categories can be manually adjusted or changed if necessary. The results are written to an ASCII file called NWA.ERG in Statement 53.

All following code lines serve to produce graphical output plots for each of the three categories and the overall *quality of life* indicator. This is implemented by a loop running from 1 to 4 (Statements 55 to 114), one loop for each plot. First, output plot names, item names to be considered and the annotation subclass names are defined (Statement 56 to 79). After that page size and map limits are defined (Statements 83 to 87). Specified items are queried (Statements 89 to 101), legends are drawn and the map is finalised (Statements 103 to 112). At the end, four plots are generated, one displaying the results for the *climate* category, one for the *landscape* category, one for the *touristic facilities* category and finally one displaying the overall results for the *quality of life* indicator.

A.5 AML Source Code

The complete AML source code developed for the multi-criteria analysis is as follows (statement numbers are given at the beginning of each line):

MCA.AML

```
1    &args incover outcover
/* Multi-Criteria-Analysis Macro for generation of the ‘Regional Quality of
/* Life’ Indicator
/* (C) CS 18.08.1998 IRPUD
/* Preparing work environment and check existence of input arguments
2    &if [null %incover%] &then &return &warn Usage: MCA <incover> <outcover>
3    &if [null %outcover%] &then &return &warn Usage: MCA <incover> <outcover>
4    &if [exists %outcover% -cover] &then kill %outcover% all
5    &if ^ [exists frame -cover] &then &return &warn Plot-Coverage Frame does
     not exists!
6    &do filename &list nwa.erg %outcover%plot.gra climaplot.gra facplot.gra
     landplot.gra
7    &if [exists %filename% -file] &then [delete %filename% -file]
8    &end
/* Check existence of Look-Up-Tables
9    &do lutname &list rain.lut temp.lut towns.lut slope.lut space.lut
     elevat.lut annual.lut touri.lut beach.lut
10   &sv qfile = [exists %lutname% -info]
10   &if %qfile% = .FALSE. &then &return &warn ERROR: Infofile Look-up-table
     %lutname% existiert nicht!
12   &end
/* Generation functions for the 'Touristic Area' indicator and for the
/* 'Development of Shores' indicator.
/* Generation function can manually be adjusted / changed if necessary
```

```
tables
sel %incover%.pat
calc meantourism = ( tour_ant1 * 100 + tour_ant2 * 70 + tour_ant3 * 30 +
tour_ant4 * 15 )
res shore_tlength gt 0
calc beach = ( ( shore1_length / shore_tlength ) * 100 + ( shore2_length
/ shore_tlength ) * 80 + ( shore3_length / shore_tlength ) * 50 + ( (
shore_tlength - shore1_length – shore2_length – shore3_length ) /
shore_tlength ) * 20 )
q
/* Generating regions in the output coverage
copy %incover% %outcover%
regionquery %outcover% %outcover% zonen # noncontiguous code rain
temperature towns_area mean_slope open_space diff_elevat mean_annual
meantourism beach
res code ne ' ' and code not in {'GEW','DK','IS','NO','AL','BA','BG','BY',
'CZ','EE','HR','HU','LT','LV','NA','RU','MA'}
~
n
n
ae
displ 0
edit %outcover% region.zonen
sel code in {'CH1','CH2','MD','MK','PL1','PL2','PL3','RO','RU1','RU2','SI',
'SK','TR','UA','YU','AM','AS','ME'}
delete
quit yes
/* Adding output items to the regions' pat
&do newitem &list rain_mf temp_mf towns_mf slope_mf space_mf elevat_mf
annual_mf touri_mf beach_mf nwa_total climate landscape facilities
additem %outcover%.patzonen %outcover%.patzonen %newitem% 8 18 f 6
&end
/* Calculating utilities for the indicators by using lookup-tables
ae
displ 0
edit %outcover% region.zonen
lookup rain_mf mf-value rain.lut rain
lookup temp_mf mf-value temp.lut temperature
lookup towns_mf mf-value towns.lut towns_area
lookup slope_mf mf-value slope.lut mean_slope
lookup space_mf mf-value space.lut open_space
lookup elevat_mf mf-value elevat.lut diff_elevat
lookup annual_mf mf-value annual.lut mean_annual
lookup touri_mf mf-value touri.lut meantourism
lookup beach_mf mf-value beach.lut beach
quit yes
/* Weighting of the indicators and categories and after all adding up the
/* categories for the total indicator. Weights can manually adjusted / changed,
/* if necessary
tables
sel %outcover%.patzonen
calc climate = ( rain_mf * 30 + temp_mf * 30 + annual_mf * 40 )
calc landscape = ( slope_mf * 20 + space_mf * 50 + elevat_mf * 30 )
calc facilities = ( towns_mf * 25 + touri_mf * 25 + beach_mf * 50 )
calc nwa_total = climate * 0.33 + landscape * 0.33 + facilities * 0.33
unload nwa.erg code nwa_total climate landscape facilities columnar format
q
/* Outcomes: Drawing results in ArcPlot
/* DO-Loop: 1. Regional quality of life indicator
/* DO-Loop: 2. Plotting results for the Climate category
/* DO-Loop: 3. Plotting results for the Touristic Facilities category
/* DO-Loop: 4. Plotting results for the Landscape category
&do i = 1 &to 4
&if i eq 1 &then
&do
&sv plotname = %outcover%plot
&sv itemname = nwa_total
&sv frameclass = total
&end
&if i eq 2 &then
&do
&sv plotname = climaplot
&sv itemname = climate
&sv frameclass = klima
&end
&if i eq 3 &then
&do
&sv plotname = facplot
&sv itemname = facilities
```

```
&sv frameclass = facil
&end
&if i eq 4 &then
&do
&sv plotname = landplot
&sv itemname = landscape
&sv frameclass = land
&end
ap
displ 1040
%plotname%
pagesize 21 29
pageunits cm
mapposition cen cen
mape -1670772.128 -2386110.917 1676509.100 2295172.378
maplimits 1.5 3.1 18.35 25.1
shadeset color.shd
reselect %outcover% region.zonen %itemname% lt 30
regionshades %outcover% zonen 3
aselect %outcover% region.zonen
reselect %outcover% region.zonen %itemname% ge 30 and %itemname% lt 45
regionshades %outcover% zonen 10
aselect %outcover% region.zonen
reselect %outcover% region.zonen %itemname% ge 45 and %itemname% lt 60
regionshades %outcover% zonen 7
aselect %outcover% region.zonen
reselect %outcover% region.zonen %itemname% ge 60 and %itemname% lt 75
regionshades %outcover% zonen 8
aselect %outcover% region.zonen
reselect %outcover% region.zonen %itemname% ge 75
regionshades %outcover% zonen 2
polygonshades frame sym
lineset carto.lin
arclines frame sym
textset font.txt
textsymbol 6
textsize 50000
annotext frame
annotext frame irpud
textsize 60000
annotext frame %frameclass%
q
&end
```