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Case study

Spatial analysis – an application of nearest–neighbour analysis to tourism locations in Macedonia

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Abstract

This paper applies nearest–neighbour analysis to analysis the clustering of tourist attractions in Macedonia and thus represents a case study for this type of application. From the results suggestions are made about how to best develop tourism in the area surrounding Prespes. The model indicates that a concentration upon traditional houses at Agios Germanos, Prespa and Psarades may form a logical centre for tourism development. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: Nearest-neighbour analysis; Pattern of points in the space location (clusters); Functional diagram; design models; Touring and long-stay tourism; Section elevation diagram; Macedonian tourism

1. Introduction

1.1. The nearest–neighbour analysis

Initially, nearest–neighbour analysis was conceived and proposed by the ecologists Clark and Evans (1954) and was considered appropriate for a large number of points which were randomly distributed in a given space. Later Pinder and Witherick (1973, 1975) and Ebdon (1976) improved the mathematical modelling to enable an analysis that would be applicable for every form of distribution of the point-patterns in the space, even in these cases where the number of points is low. This model is stated as

$$dr = [\sqrt{(a/n)}], \quad (1)$$

where dr is the theoretical average distance.

The coefficient C is calculated by the relationship

$$C = 0.497 + 0.127\,[\sqrt{(a/n)}],$$

where a is the area of framed space of exploration and n the number of points of exploration, and

$$do = \sum(\text{of the closest distances})/n \quad (2)$$

with do being the observed average distance.

From the relations (1) and (2) we estimate the nearest–neighbour ratio

$$R_n = do/dr,$$

where R_n is the statistical test of the nearest–neighbour analysis.

The method gives estimations for the form of the points in space (e.g. it clarifies whether the question is about clustered, uniform or random distribution). The value of nearest–neighbour ratio indicate a average distance. It is theoretically an indicator of evaluation based on the statistic exploration of the null hypothesis of a random distribution. Uniform forms of point distributions in a pattern has a R_n-value: $R_n > 1.00$. The theoretical maximum of R_n is about 2.15 (for a uniform hexagonal pattern). A clustered form has ratio values $1.00 > R_n \geqslant 0.00$. In this case the value of R_n indicate a complete occupation of all the points in the pattern which means that all the points in the pattern are closer together than expected (Smith, 1995).

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1.2. The application of the mathematical form in spatial analysis

The mathematical method was later developed so as to render its application to linear spatial analysis. Pinder and Witherick (1975) made use of the methodology in cases of serving installations along a road net of a riverside area. Smith (1993), by adjusting a part of Europe in square frames, analysed the spatial distribution of thermal springs in Europe.

In its application to tourism, three immediate considerations must be taken into account. The first in the limitations imposed by topography, while the second is the definition of the area to be contained within a rectangle "imposed" on the studied region. A third issue is that, because of the different demand patterns, it is necessary to distinguish between touring visitors who pass through an area requiring but a short stay and others who have a demand for longer stay accommodation. According to Horovitz (1992), the client who stays for a long period of time at a destination (long-stay situation), has a greater demand for a more personal and informal process in any given service. In contrast, the touring client requires more formal proceedings. Likewise, this kind of distinction according to Gunn (1988), can be useful to the planning process due to an easier distinction of Tourism typologies based on travelling activities and attractions.

1.3. Design and interferences in paterns of points (clusters) and in chosen spots of space with the use of functional diagrams and section elevation

Gunn (1988) and McIntyre et al. (1993) both suggest a classification and modelling of areas based upon nearest neighbourhood analysis. Table 1 indicates their proposed mixing of geographical regions with different functional models, which models are briefly described below. The categorization preserve the distinction between touring and longer-stay tourism (Gunn, 1988, pp. 40–44).

The analysis of particular points is visually improved by use of section elevation diagrams. These diagrams show sections of facades with the points which are found on the imaginary line of each section. According to Reid (1987), section elevations show the horizontal communication of the points.

Several classes of attractions can be grouped in the following models for tourism development. First, as noted, tourism development can be grouped into two (touring and long stay tourism). The next four models include thirteen classes of touring activities. Model A describes functional relationships for roadside visits, natural areas and campsites. Model B describes relationships for water based activities and touring. Model C emphasizes residents' home areas and near attractions for visits, like parks, museums, scenic areas, sports areas, entertainment and specially food services. Model D applies to travel objectives in cities. The seven longer stay tourism models include 11 classes of long-stay tourism activities. Model E describes general relationships for resorts that include communities, accesses, attractions, services. Model F illustates the development of natural resources – camping areas, hunting and water sports areas. Model G focuses on the description of camping land use development. Model H illustrates the development of holiday-home uses. Model I gives emphasis to the development of Festival and Event Places. Model J relates to urban destination development and model K illustrates a longer stay development for National Park areas.

By making use of the above classified functional diagrams and section elevation diagrams, the practical use of the spatial analysis in the planning of tourism products will be emphasized. Here the technique is applied to the region of Prespes with specific reference to the traditional houses located at Agios Germanos (see Fig. 1). The analysis is presented in the form of functional diagrams. Finally, a variation of the diagram of the section elevation type is proposed. The diagrams of the section elevation type show in the form of a "Facade", the selected points in the space and their special characteristics. The improved diagram emphase the presentation of useful information and visual thematics in order to achieve the best possible adjustment of the destination's characteristics to the characteristics of tourist segments (see also Lehmann & Winer, 1997) and in the long run it promotes the strategic development of touristic products with destination zones.

Table 1
Crosswise table of distribution of stereotyped models from functional diagrams of analysis of touristic activities in space

Classification of McIntyre et al. (1993)	Classification of Gunn: functional diagrams for attraction classes	
	Touring	Long stay
1. Coastal areas	Model B	Models E, F, H, I
2. Mountainous and virgin areas with wild vegetation	Model A	Model H, K
3. Rural inland areas	Model G	Model H
4. Urban areas	Models G, D	Models I, J, K
5. Small islands	Model B	Models E, F, H, J

2. Case study: application of the analysis in the region of West Macedonia

Fig. 1 shows the distribution of natural and cultural resources in the framed region of West Macedonia. The

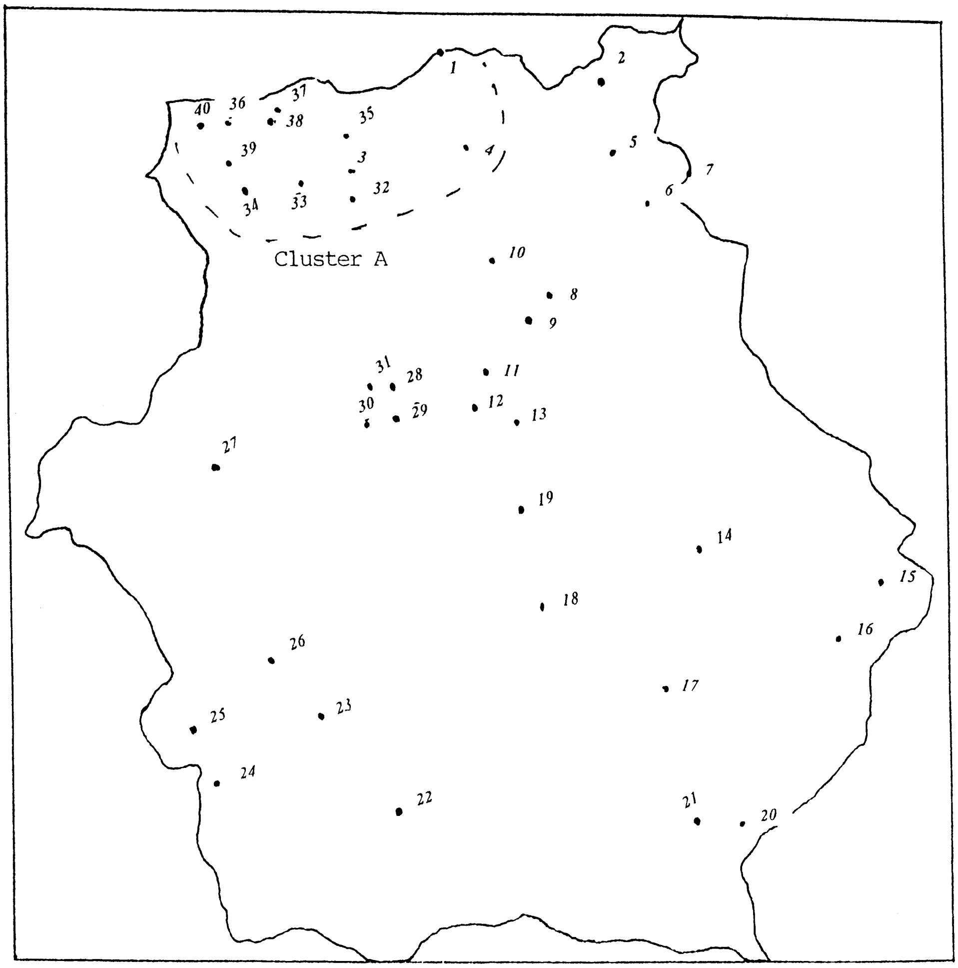

Fig. 1. Points in the space location of W. Macedonia.

region was framed inside a square that has the following dimensions: 19.5 cm × 19.5 cm. The calculations of the short distances between points have been made in the centimetre scale. The measurements per pair of points are presented below in Table 2. R_n has been calculated based on form (3) (Pinder, 1978). Finally the application of form (3) based on Table 2, provides the results shown the right of the table. Thus, $R_n = 0.087$ and following Smith (1993), this indicates a clustered arrangement of locations as R_n approaches zero.

Among other things in Fig. 1, it appears, on the left corner of the square, that there is a "gathering" of points in the lake area of Prespes. In this area, as well as in others in West Macedonia, is found a discernible density of point "collection". Each one of these areas constitutes an "exploration cluster" for the development of possible touristic activities. The alternative possibilities of the development of the touristic activities, "Touring and Long Stay Tourism" in Cluster A is examined below with special reference to the shaded area of Fig. 1 (see Table 3).

2.1. Exploration in cluster A

The strategic planning and the organization of the natural and cultural resources have been done with the assistance of the alternative design models below.

According to Tables 1 and 4, in the case of Agios Germanos (point 37), the design model of form D may be used to aim at the development of "Touring Visitors" (see Fig. 2b). The strengthening of the substructure of this point by the State (e.g. by increasing the number of beds) would contribute to the application of model H (holiday resorts) and the development of "Long-Stay Tourism". It should be noted that the autonomous exploration of points is indicated, particularly for the distant observation points or wherever the total exploration of the short-distance points is impeded by natural obstacles (e.g. mountains, ravines, seas).

In the case of development of Agios Germanos as a Long-Stay Tourism point, the points 38 (model D), 35 (model A), 36 (Model K), 39 (models K and B) could constitute poles of attraction for touring and for the

Table 2
Nearest–neighbour analysis for pattern in Fig. 1

Nearest–neighbour distances (cm)	
1–4	2.1
2–5	1.5
3–32	0.5
4–1	2.1
5–6	1.2
6–7	1.1
7–6	1.1
8–9	0.7
9–8	0.7
10–8	1.4
11–12	0.8
12–11	0.8
13–12	0.9
14–17	3.0
15–16	1.5
16–15	1.5
17–21	2.7
18–19	2.0
19–13	1.8
20–21	0.9
21–20	0.9
22–23	2.5
23–26	1.5
24–25	1.2
25–24	1.2
26–23	1.5
27–30	3.2
28–31	0.5
29–30	0.6
30–29	0.6
31–28	0.5
32–3	0.5
31–32	1.0
34–39	0.6
35–3	0.7
36–40	0.5
37–38	0.3
38–37	0.3
39–34	0.6
40–36	0.5

$\Sigma = 47.5$ or 475 km
$do = 475/40 = 11875$ km
$dr = [0.497 + 0.127[\sqrt{(38025/40)}]][\sqrt{(38025/40)}]$
$= 4.4126902 \times 30.832207$
$= 136.05297$ km
$R_n = do/dr$
$= 11.875/136.05297$
$= 0.0872822$

increasing the visitor's experiences (see Table 3 and Fig. 2a–c).

The corresponding functional diagram for the co-operation of the points is (Fig. 2b).

Based on the above figures the process of the development of a broader variety of attractions in the area of the observation point can be examined as a "cooperation" of adjacent points of the area. In this way, point 37 "cooperates" with the adjacent points which are easily accessible by the visitors and on the other hand they are attractively unique. In our case points 36, 35, 40 have been chosen.

The following scheme of analysis and design of tourist activities (section elevation diagram) is suggested for the best possible design of destination of the Prespes area (the main point is point 37).

Table 3
Point analysis of cluster A – Description of the points

Point no. and name of the place	Description
1. Niki	National Tourism Organisation in full stations on the frontiers
3. Pisoderi Village	Traditional homes
4. Armenochori	Ancient Monuments
32. Ski Center Pisoderi	Sports
33. Antartiko	Traditional Houses
34. Mikrolimni	Landscape – Lake
35. Varnus	Landscape – Mountainous area
36. Prespa	Landscape – Lake – Archaeological sites
37. Agios Germanos	Traditional houses
38. Lemos	Traditional houses
39. Mikri Prespa/ Agios Achillios	Landscape, Lake – Traditional houses
40. Psarades	Traditional Houses

Table 4
Points and design models

Point	Models	Strategy
37. Agios Germanos/ Traditional homes	Functional diagram type D for *historical and cultural elements*	Touring
	Functional diagram type H for *holiday resorts*	Long-stay tourism

2.2. The model of "thermometrical users" (the section elevation diagram)

To achieve a more analytical presentation of some of the chosen points architectural diagrams of the section elevation form can be used. It is assumed that due to the nearest possible access, the ideal route of the exploration area is the linking of points 37, 36 and 40. According to Giotart's classification (Giotart, 1996) this region can be classified as coastal touristic destination focusing on Touring and attracting tourists who are seeking for a cultural stay. On the highest point of the above diagram (Fig. 3), the geographical section AA of the points of analysis is shown (see Fig. 3a). These points are found along the road. Then the corresponding distances between the points of section AA (see Fig. 3b) are presented.

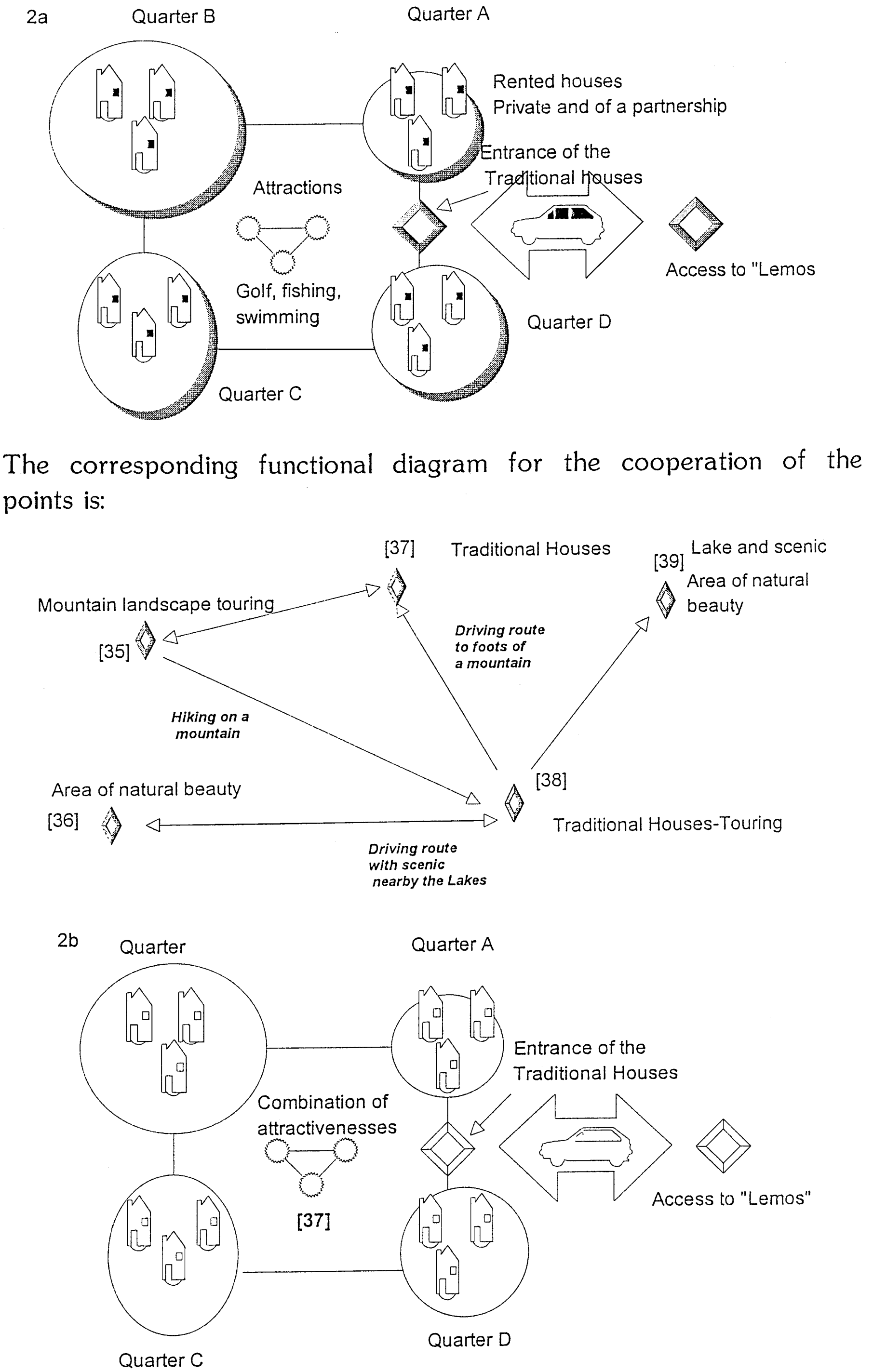

Fig. 2. Visual diagrams: (a) functional diagram for the point 37 aiming at the development of long stay tourism; (c) functional diagram for the point 37 aiming at the development of Touring Visitors.

Afterwards the diagram is enriched with data regarding the behaviour of possible segments (see Fig. 3c).

The horizontal rods have been called "thermometrics of users" because their function is similar to that of a thermometer. As already mentioned, the areas of the points are presented on the scheme and the following rod of "thermometrical" measurement constitutes the indicator of the adjustment ability of the points. The rod is an indication of "powerful" or "weak" adjustment of the tourist product based on the attitude of possible segments of visitors. The more intense the colour of the rod, the more powerful is the congruence between site

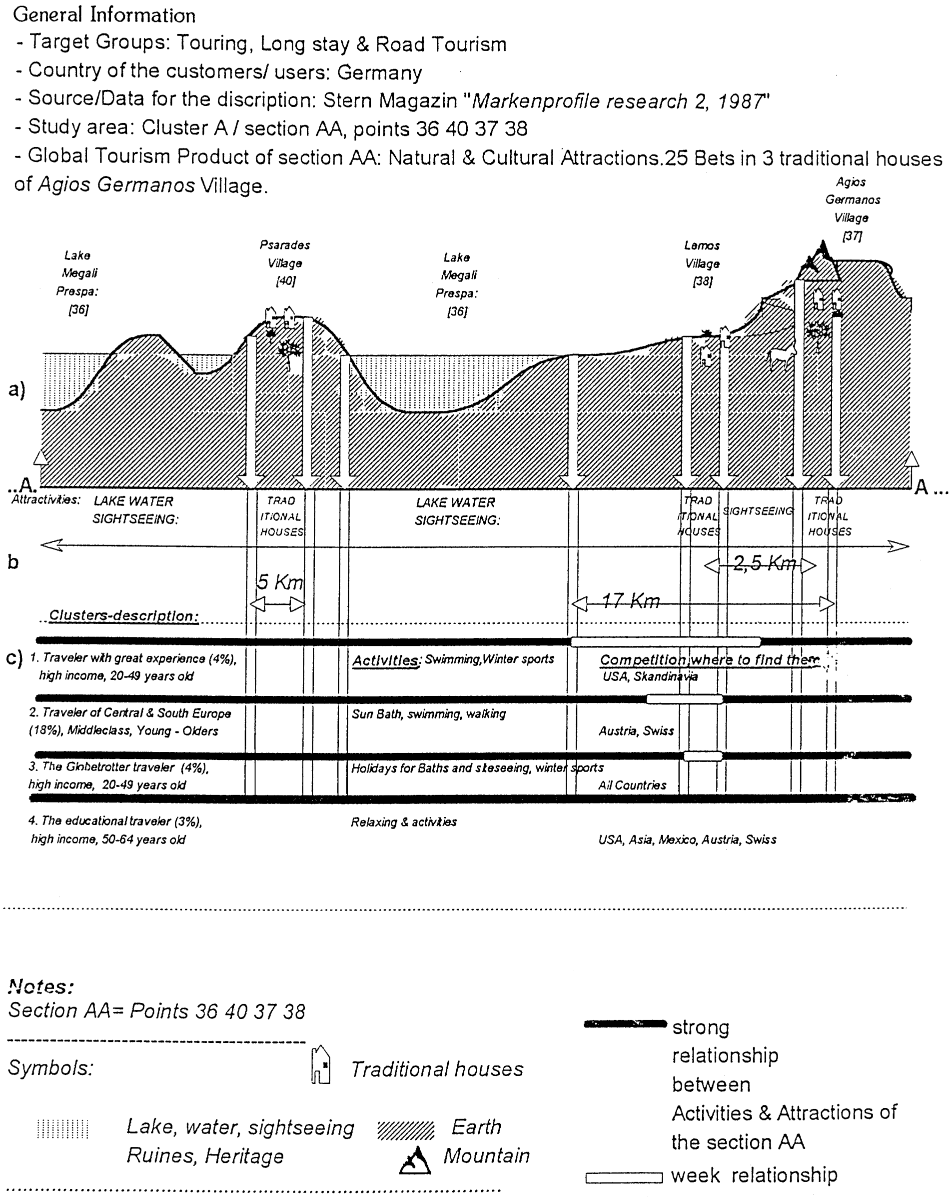

Fig. 3. Section elevation diagram – analysis of section AA.

attributes and tourist preferences expressed by the target tourist segments. Moreover, the suggested procedure for the greation of a section elevation diagram with emphasis on the procedure of thermometrics of users follows two basic steps:

(1) The collection and presentation of general informations concerning the profile of visitors and the development of touristic activities.
   (a) determination of specific target groups (touring strategies and long stay tourism),
   (b) the demographic data of visitors (nationality, etc),
   (c) the points in the section of examination (interest),
   (d) short presentation of touristic resources in points (beds, attraction characteristics).
(2) The design and presentation of section by level (see Fig. 3a–c).

The presentation by level consists of

- Geographical characteristics and the environment in the section,
- The analysis points. The code number of every point is given by the previous nearest–neighbour analysis.
- The mile distances are printed between the vertical lines. The vertical lines separate the geographic areas of examination (interest).

- The most important characteristics of the profile of visitors which are included in every cluster. These characteristics are come from research studies.
- The presentation of horizontal rods (thermometrical rods) which are here shown in a grey color and indicate the points of identification of the characteristics of the tourist product that match perceptions of the segmented visitors.

2.3. *Conclusions of the use of the section elevation diagram*

According to the section elevation diagram the points of section AA are indicated for the attraction of four possible segments of visitors related to long stay activities (see Fig. 3c). The adjustment areas of interest that each segment shows with the special characteristics (natural and cultural) of the tourist product of the exploration points (see Fig. 3, points in section AA), indicate a strong relationship. The intense colour of the rod goes beyond the 50% of its total length.

3. Conclusions – subjects for further research

The above research methodology of the potentials of touristic development of particular geographical areas requires:

(a) The examination of the form of the distribution in geographical space according to the nearest neighbour analysis.

(b) An analysis of the points according to functional diagrams that deal with strategies of development for touring or long stay tourism.

(c) Finally, the mixing of the tourism product of the chose}0n points with the characteristics of the visitors' attitude seems to constitute an useful and easy means of collecting information for assistance in administrative matters.

The analysis could include also the total number of beds or bedspaces at each point. Also, the standards of the public services (transportation, public and private services) could be examined. The application was done at a particular geographical space of the region and included only a few adjacent points. The function and section elevation diagrams and the table of standardization of the functional models could constitute a basis for the stereotyped design of tourism areas. The creation of an electronic algorythm would contribute to this, where, based on facts obtained from research (e.g. data with descriptions for segments of visitors), the appropriate areas of the broader geographical destination can be indicated. The data could include for further analysis, the tourist industry, accomodation of the communities, public organisation and its offices, media and rivals (Swarbrooke, 1994).

The analysis by means of section elevation diagrams can be applied to broader geographical regions. That is instead of one section (AA) we could create an electronic programme of visual analysis of many sections with three-dimensional images i.e. section BB, CC, etc., including the specific geographical, cultural, touristic etc elements of the regions. The procedure begins with the creation of the sections. Then it may be directed towards recent elements, for example data based on visitor types. After comparing the research elements with the special sections, it is possible to identify and examine matching fields by use of "thermometrics of users". Such analysis will show possible development points for long or touring tourism, per segment of visitors.

Strategically, this approach would assist the planning procedure and the development of touristic activities undertaken by tourism planners in geographical regions in the following ways:

- There would be touristic development concerning (a) the improvement of touristic substructure and (b) the projection of adjacent touristic resources for every segment of visitors.
- With the classification of touristic activities concerning the development of appropriate touristic programmes for long and touring tourism at adjacent or distant points of a particular geographical region.

This case study itself shows how a careful assessment of linkages between different locations in Prespes permit an identification of key locations in developing specific forms of tourism development, while highlighting the nature of the linkage between access routes, tourist activity and tourist infrastructure. It is thus argued that nearest–neigbourhood analysis can serve both the function of better understanding the nature of tourist zones, and subsequently aid in planning better utilisation of those zones.

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