A MULTI-ATTRIBUTE ANALYSIS OF SPATIAL CHOICE BEHAVIOUR

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Abstract

The paper focusses on spatial diffusion patterns of human settlements in the Netherlands. After a survey of the post-war urbanization, suburbanization, des-urbanization and re-urbanization trends, a conceptual and methodological framework for spatial choice analysis is presented. Both a macroscopic and a microscopic approach is discussed, followed by some models to study the determinants of spatial population developments. These models were applied to Dutch data in order to identify the relative importance of quality-of-life indicators upon migration decisions and migration propensities. The paper concludes with some policy aspects.

Contents

1. Introduction

The study of mobility patterns and spatial allocation patterns can be regarded as a central issue in regional and urban sciences. The traditional view of the structure of human settlement patterns has borrowed many ideas from neo-classical location theory, in which residential location decisions (and its resulting mobility patterns) were assumed to arise from a cost-minimizing or utility-maximizing principle. In this way, a fairly simple economic decision criterion could be used as a key element in analyzing human settlement systems.

The spatial distribution patterns of population over cities and functional urban areas have demonstrated, however, significant changes during the last decade. Therefore, the question arises whether a traditional residential location analysis is still valid. During the last decade, especially in the western industrialized countries the welfare state has reached its full growth. It is reasonable to expect that under these circumstances location and mobility decisions (and hence the spatial evolution of population and economic activities) will be guided by less purely economic-oriented criteria.

The residential location decisions appear to be increasingly influenced by environmental quality aspects and by the quality of the housing stock. Entrepreneurial location decisions appear to be co-determined by quality-of-life indicators and the availability of social facilities. The mobility patterns associated with recreation, tourism and shopping appear to reflect the increase in leisure time in our welfare society.

Consequently, phenomena such as the urban decline, the spatial deconcentration and the development of functional urban regions cannot be studied any longer by means of traditional and simple unidimensional location criteria. In our opinion, spatial evolutions of urban systems are to be ascribed to a wide variety of multiple attributes, which reflect the key elements in human location decisions. It is clear that such a broader insight into the determinants of spatial evolution processes is a prerequisite for developing strategies for effective urban and regional planning.

The aim of the present paper is (i) to provide a brief picture of spatial developments in the Netherlands, especially as far as the evolution of infrastructural and urbanization processes is concerned, (ii) to present a methodological framework for studying these processes, *inter alia* by means of qualitative multi-attribute methods, and (iii) to illustrate the significance of this methodological framework by means of some empirical applications for the Netherlands.

2. Spatial Developments in the Netherlands

The shifts in the structure of an urban system, the changes in the spatial communication and infrastructure pattern, and the regional developments are usually phenomena which occur simultaneously and in close mutual coherence (cf. Gauthier, 1970). Especially the improved communication (radio, television, e.g.) and the improved infrastructure have led to a decrease in (actual and perceived) spatial frictions, not only in a physical sense, but also in a psychical sense. The improved accessibility of former isolated hinterland regions has increased the spatial sphere of influence of the urban core, so that spatial multiplier impacts (cf. the export base theory) show a less demarcated and a more diffuse dispersion pattern. The same holds true for the geographical diffusion pattern of the impacts of growth poles and of a spatial system based on central places.

In the Netherlands, the transition from an agricultural-commercial to an urban-industrial society has led to both a spatial concentration and to a regional differentiation, for example, a concentration of the service sector in the Western part of the country (Van der Knaap, 1978). Especially the period 1900 - 1910 plays a key role in the history of Dutch urban developments from 1840 until now. During the period 1900 - 1910 the relatively rapid growth of the population concentration in the three largest cities (Amsterdam, Rotterdam, The Hague) came to an end. In that period, 25% of the total population lived in these 3 cities. From 1910 until 1970 the population share of these cities has decreased to 20 %. In other words, from 1910 onward the large cities have shown a lower growth rate than the national average.

The latter development has manifested itself even more sharply during the last decade: the growth of the three big cities has stopped and turned into a decline of population. Even the urban agglomerations of these cities have shown some decline in population. During the same period, however, the medium-size cities have grown substantially, while also the small-size places (especially those located close to large and medium-size cities) have shown a high growth rate.[1)]

Van der Knaap (1978) has shown that this evolution of the urban system in the Netherlands is closely linked to the growth of the physical infrastructure such as railways, canals and motorways.

The improved infrastructure and the shifts in human priorities for a better quality-of-life can be held mainly responsible for the changes in spatial patterns in the Netherlands. During the fifties the Netherlands were marked by a spatial movement toward the Rimcity (the urbanized Western part), especially from the

1) This development is in agreement with observations of Beale (1977), and Berry and Dahmann (1977), although the influence of the spatial scale of analysis should be taken into account (cf. Gordon, 1978).

Northern part. This migration was especially due to the better employment conditions in the Rimcity, while also the bad perspectives for agricultural labourers in the North was a reason to move to the West.

During this period of significant spatial evolution processes the first signs of a spatial dispersion of residential patterns around big cities could be observed. Especially the lack of dwellings in main centres was an important reason for a pressure on suburbs. In particular, the higher income groups appeared to be able to cover the higher expenses of a location at the periphery of the big city. This initial stage of the suburbanisation movement was clearly a selective process for certain socio-economic groups.

During the sixties the extensive suburbanisation movement started in the Netherlands (see also Van den Berg et al, 1978). The largest cities were marked by a population decline, while the medium and small-size places demonstrated an enormous growth (up to 25 to 30 percent over 10 years). These significant shifts in location patterns can hardly be ascribed to purely economic causes, but are closely related to the priorities for a higher quality-of-life (see also Nijkamp, ,1977a).

Such a far-reaching spatial movement was furthered by the improved infrastructural connections, the increased use of private transport and the growth in income, while the out-migration from large cities was furthered by the lack of adequate dwellings. It should be noted that also during the sixties this spatial evolution of settlement patterns was a selective process. Particularly, the medium-income groups were able to choose a location in a place around the main centre instead of a location in the urban core itself. Those who stayed in the urban core often belonged to specific groups: elderly people, single or young people, foreign labourers and low-income groups, etc. Especially in older urban districts this selective out-migration process has led to a special and often unstable social structure (cf. Van den Berg and Klaassen, 1978).

Apart from urban developments, also significant changes at the regional and provincial level took place. After the period of high immigration rates in the Western part of the country, during the sixties a considerable out-migration could be observed, especially to Eastern and Southern provinces. Consequently, the urban growth in provinces such as Gelderland and North-Brabant rose above the national average, while the urban growth in the Rimcity fell below the national average. It is a plausible assumption that the differences in regional living conditions and residential conditions exerted a major influence on this spatial movement (see section 5).

The pressure on the so-called 'green areas', especially in densely populated areas, increased considerably due to the abovementioned spatial development. The paradoxical situation occurred that those who attached a high value to better living and environmental conditions were at the same time affecting the stock of environmental commodities due to both their movement to 'green areas' and the resulting commuting patterns.

The abovementioned suburbanization movement did not stop with the migration movement to smaller places at a distance of 20 to 40 kilometers from the central city. The population growth and later the decline in family size caused a permanent demand for dwellings. Since the stock of dwellings in the central city and in the functional urban core (including the first ring.of suburbs) was insufficient to satisfy the demand (in a qualitative and in a quantitative sense), a further out-migration process from urban agglomerations took place. The out-migration and the decreased occupancy rate of dwellings led to a decline of population in the city and sometimes in the urban agglomeration (or functional urban core). This so-called desurbanization movement (cf. Klaassen, 1978) has sometimes even led to a decline of functional urban areas, especially in the Western part. This process was again a selective process, because in this period also lower-income groups started to leave the city.

Due to the limited stocks of dwellings in cities and surrounding rings of suburbs and of small places and due to the higher priorities for a highly-qualified residential and living-environment, in the seventies a further long-distance suburbanization movement took place, by which the whole spatial structure of functional urban regions was changed. Extensive commuting patterns were the most significant results of this spatial process. Especially the provinces Utrecht, Gelderland and North-Brabant were seriously affected by this commuting process to the Rimcity. This long-distance commuting process was again selective, because mainly the high- and medium-income groups could bear the costs of daily long-distance commuting. The consequences of this spatial movement are fairly clear: lack of infrastructural capacities, congestion, high energy use (cf. Vonk, 1978).

It should be noticed, however, that in addition to a desurbanization process recently a re-urbanization trend has started to emerge. In the Netherlands, urban renewal projects receive a lot of attention, especially in older urban districts from the previous century. It is hoped that in this way also the lower-income groups will be provided with better living conditions. This urban revitalization process appears to result now in a moderate re-urbanization. Particularly, older districts with modernized houses and a fairly good accessibility are becoming more and more attractive, so that sometimes people start te return to the city centre (for example, to the rings of canals in Amsterdam). This spatial process is again a selective process, because mostly only the richer people can afford to buy or rent a favourably located and modernized house in the urban core.

Some of the abovementioned trends are reflected in Figures 1, 2 and 3, which represent the surpluses of internal migration per group of municipalities (dis-

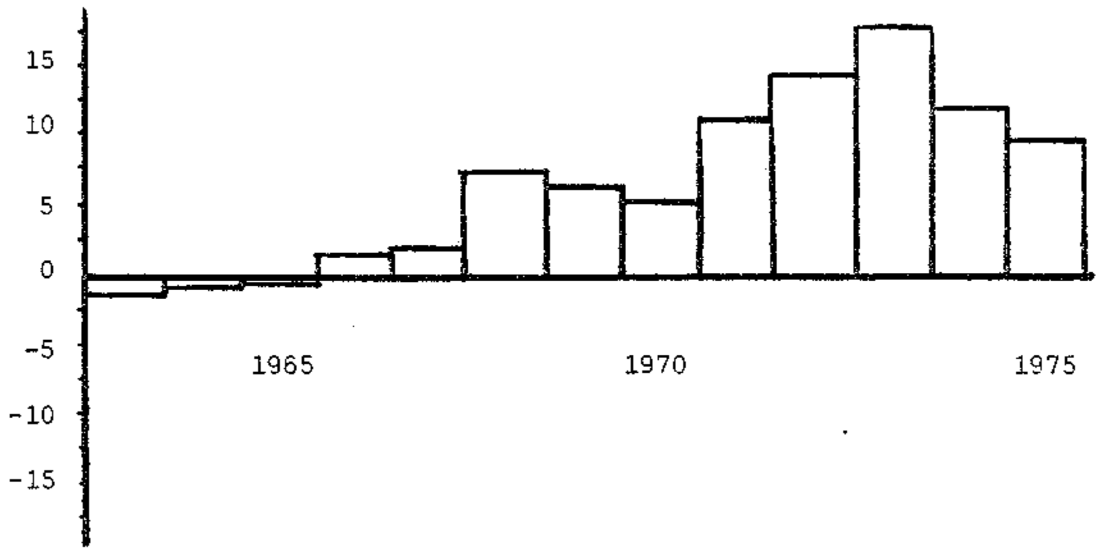

Fig 1 Surpluses of internal migration of rural municipalities by degree of urbanisation 1960 (per 1,000 of the population on January 1st)[1)]

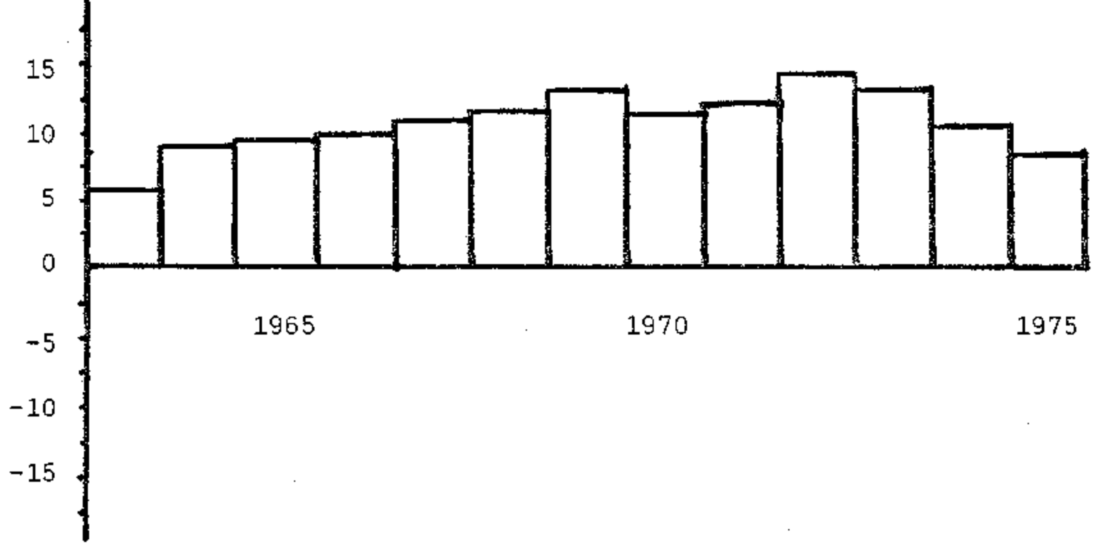

Fig 2 Surpluses of internal migration of the urbanised countryside by degree of urbanisation 1960 (per 1,000 of the population on January 1st)[1)]

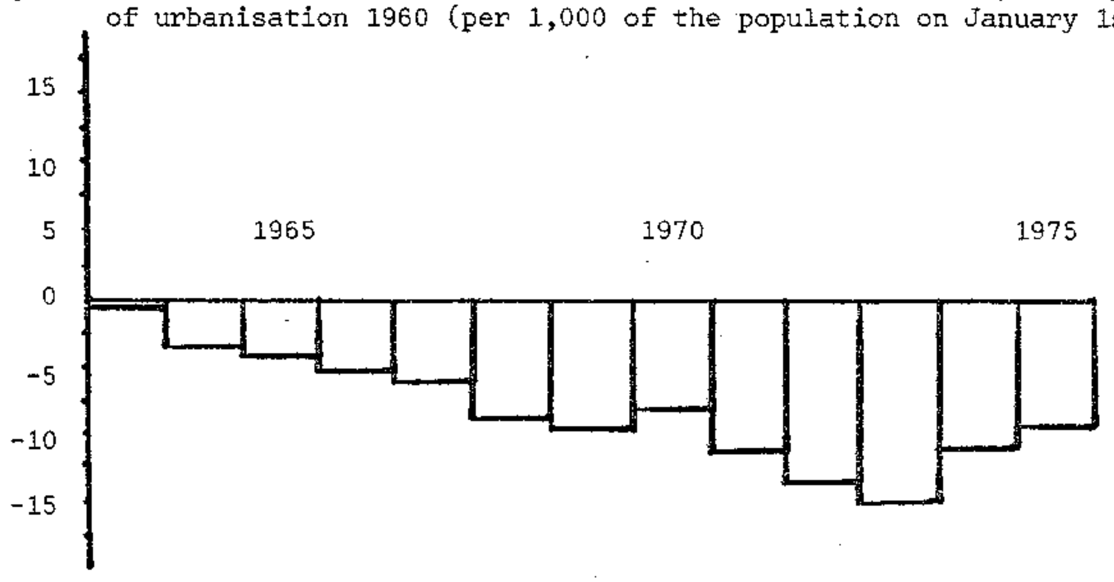

Fig 3 Surpluses of internal migration of urban municipalities by degree of urbanisation 1960 (per 1,000 of the population on January 1st)[1)]

1) Source: Internal Migration Statistics 1974-1975, Netherlands Central Bureau of Statistics, Staatsuitgeverij, The Hague, 1977.

tinguished by degree of urbanization in 1960). These group of municipalities are the rural municipalities (especially in peripheral areas), the urbanized countryside (industrial rural municipalities and specific resident municipalities of commuters) and the urban municipalities (small towns, country-towns, medium-sized towns and large towns).

This pattern once more shows the steady decline of urban municipalities from 1963 onward, although from 1973 onward a slight recovery can be observed. The urbanized countryside appears to attract a steady flow of migrants, while especially from the end of the sixties the rural municipalities show also a considerable migration surplus.

It should be added, however, that several big cities have indeed been marked by a loss of residential functions, but that the majority of large Dutch cities has kept or even extended its other functions: supply of shopping facilities, of cultural facilities, of educational facilities, and of medical facilities. Some cities, however, demonstrate also a fairly unbalanced labour market and a loss of jobs due to structural changes in technology and international developments (for example, in the ship building industry). Another problem is the frequent lack of adequate outdoor recreation facilities in big cities, which induces once more a further urban sprawl.

An additional complication is the fact that the suburbanization has affected the financial carrying capacity of big cities, so that the quantity and quality of urban facilities may be affected.

The spatial developments in the Netherlands sketched above briefly can be judged positively, in as far as they provide a higher satisfaction level for individuals: better living conditions, more social contacts, and more participation in a wide variety of public amenities. The negative consequences, however, are also evident: a high pressure on scarce space, a further environmental decay and an energy-intensive spatial structure.

As indicated before, the decision to choose another location is influenced by a wide variety of different factors: employment, accessibility, recreation facilities, shopping facilities, social circumstances and last but not least, environmental conditions. Therefore, a further analysis of the determinants of the abovementioned spatial evolution has to be based on a multi-attribute approach to spatial behaviour (cf. Lancaster, 1971; Nijkamp, 1978; Nijkamp and Van Veenendaal, 1978). In the next two sections, this problem of spatial behaviour and spatial preferences will be analyzed in more detail.

3. Spatial Choice Analysis

The analysis of human choices is of permanent concern in the social sciences. Two broad categories of analytical contributions to the study of preferences and choices may be distinguished, viz. the classical approach and the behavioural approach.

The classical approach is based on the well-known notions of utility and indifference. By means of choice criteria which are identical for all subjects the conditions for optimal decisionscan be derived. In a spatial setting, this approach aims at forecasting spatial interaction patterns, given the traditional assumptions about rational behaviour and perfect information of individual choice-makers. Examples of this approach can be found in the classical Christaller-Lösch framework. One may doubt, however, whether the assumptions of rational decision-making under perfect information are valid for spatial choices such as migration, commuting and shopping. In fact, these methods fail to describe and explain actual spatial and socio-economic processes. Although some of these methods have been placed in a broader institutional framework, they have not yet been appropriate to identify human preferences and to predict (spatial) economic choices.

The behavioural approach can be subdivided into the revealed (space) preference approach and the direct preference approach.

The revealed (space) preference approach attempts to explain spatial processes, structures and preferences on the basis of (mainly aggregate) information on past spatial behaviour (cf. Rushton, 1969, and Samuelson, 1953). Such an ex post analysis can also be used to predict future behaviour. This analysis rests mainly on assumptions from behavioural philosophy and psychology which state that human preferences and intentions can only be inferred ex post from actual behaviour. It should be noticed, that an application of a revealed preference approach takes for granted the consistency of individual choices (transitivity), a similar ranking of alternatives among all individuals and a sufficiently long time period to define indifference (Little, 1949, and Pirie, 1976). For these reasons, revealed preference methods reflect consistency of spatial choice behaviour rather than preference-based laws of spatial behaviour. It should be added, however, that the revealed preference method is not always exclusively applied to actually chosen alternatives. Rushton (1971), for instance, has taken into account opportunities which were rejected but nevertheless did exist at the moment of the actual choice.

The direct preference approach employs (mainly individual or micro-economic) recent information on preference rankings of spatial choice-makers (for instance, from interviews). This information can be used to detect an (aggregate) structure in preference rankings and to assess expected future spatial processes. In contrast to the revealed preference method it is also possible to deal with future preferences for not yet existing opportunities.

The revealed preference approach is frequently a macroscopic method due to the aggregate character of the data on spatial choice behaviour, while the direct preference approach is often a microscopic method due to its ability to deal with individual preference data (see also section 4). Both the revealed preference approach and the direct preference approach can only forecast spatial processes and structures in as far as behaviour can be based on personal preferences and perceptions. Bandwagon effects, snob effects and Veblen effects are very hard to integrate in these analyses (see also Leibenstein, 1976). Furthermore, making no choice is also a choice, while many choices are either based on a random process or determined by strict limits (daily goods, e.g.)(see Houthakker, 1965). Consequently, a choice is not always based on an unambiguous discretionary preference ordering. Thus both the revealed preference approach and the direct preference approach have certain limitations which should be kept in mind (see also Russell, 1921, and Sen, 1973). In our opinion, however, especially the direct preference approach offers a fruitful possibility to gauge human priorities.

Another important element in spatial choice analysis is the possibility of a simultaneous achievement of multiple goals. Examples are multi-purpose trips and multi-purpose migration decisions. The latter situation gives especially rise to a multidimensional view of spatial choices (see also section 4). Such a multidimensional view presupposes the ability of human mind to select and store information on different attributes, to evaluate alternative choice possibilities via multidimensional images, mental maps etc., and to make a selection on the basis of an implicit utility functions or explicit optimizing criteria.

In this respect, multidimensional scaling techniques may be extremely useful, especially in case of a direct preference approach[1]. These techniques are particularly important when preference rankings are available, so that essentially non-metric information has to be dealt with.

Such non-metric information can be transformed into metric information of a lower dimensionality by means of multidimensional scaling methods especially developed in mathematical psychology (see for a survey among others Nijkamp and Van Veenendaal, 1978, and Voogd, 1977). These methods provide the tools to extract from individual perceptions of spatial attractiveness items, a smaller set of quantitative (metric) attractiveness measures.

The basic feature of these multidimensional scaling methods is that (dis)-similarities among attributes or items can normally only be ranked by individuals and groups in an ordinal sense. By employing a multidimensional scaling algorithm, a geometric representation of the position of the attributes or items as well as

1) These techniques, however, are sometimes also used to explain ex post behaviour (see Rushton, 1971, 1973).

of the individuals or groups can be derived in a space of a given, but lower dimensionality. The representation of the originally ordinal data in a new geometric space with fewer dimensions implies that more ordinal conditions are available than geometric coordinates are necessary. Hence, the scaling methods use the degrees of freedom to transpose ordinal input data into metric output data. The coordinates of the positions of the attributes and of the judges are to be determined such that the interpoint distances between the points in a geometric space do not contradict the ordinal conditions implied by the input data. In other words, this monotonicity condition should guarantee a correspondence between the original (ordinal) (dis)-similarities and the Euclidean distances in a geometric space with a lower dimensionality. The mathematical technique itself will not be exposed here, but can be found in the references quoted above.

By means of these scaling methods, the relative differences in priorities for certain items or certain criteria can be assessed in a cardinal sense, so that the degree of mutual (dis)agreement in spatial perceptions and choices can be quantified. For example, assume an ordinal paired comparison table for N characteristic features of a certain location. This means that we have determined for these N objects N(N-1)/2 ordinal statements (or conditions). A representation of these N objects in a two-dimensional Euclidean space requires only 2 N numbers, viz. the Euclidean coordinates of N points in a two-dimensional space. Thus, the N(N-1)/2 ordinal relationships can be used to identify 2 N cardinal numbers (see Fig. 4). Given the coordinates of the points in Fig. 4, metric statements about the cardinal differences between the successive attributes can be inferred.

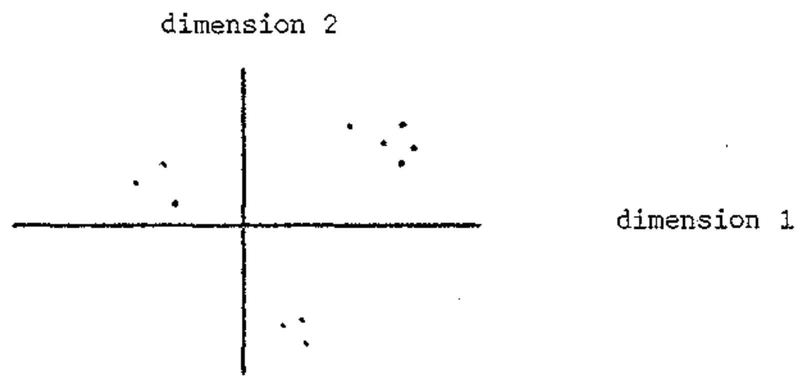

Fig. 4. Figurative representation of results of a scaling procedure in a two-dimensional space.

So it is clear that the major part of these scaling methods are based on a cognitive approach, in which individuals judge directly observable and mental stimuli with respect to differences between these stimuli on the basis of a set of attributes. These differences are mentally combined in some or other way to make an overall judgement of similarities or preferences (see also Harman and Betak, 1976).

The following comments regarding the use of multidimensional scaling methods for perception and preference analysis can be made:

- A scientific discussion of mental images of attributes or objects is possible, because in this approach human mind is not a metaphysical concept (see Burnett, 1976, and Harrison and Sarre, 1971). An interpersonal comparison of perceptions and preferences is possible as well (in contrast to the traditional view of Pareto, 1906).

  In behaviourism, the assumption is made that the human mind is not independent, but that there is almost a tautology of mind and behaviour (see Burnett, 1976). This methodological background is mainly dominating the revealed preference methods and, to a lesser extent, the (spatial) preference and perception methods.[1] This implies that a behaviourist view of the world can only offer a partial explanation of spatial developments.
- The attributes or stimuli derive their relevance from their cognitive meaning and not in the first place from objectifiable aspects. In Nijkamp and Van Veenendaal, 1978) an attempt has been made to correlate perceived and/or preferred recreation items with observed characteristics of the items concerned on the basis of the assumption that there is an external world of spatial stimuli with objective properties outside human mind (cf. Burnett, 1976).
- Human mind differentiates between stimuli or attributes on the basis of a continuous reference pattern, while in fact discrete manifolds may be more appropriate (Harman and Betak, 1976). Evidence also suggests that cognitive information generally relates to a limited range, context, or domain of stimuli. Clearly, this observation may hamper a straightforward comparison of totally different items.
- The perception and preferences are expressed in terms of differences between items by means of ordinal rankings. Consequently, the concept of distance (in a generalized Minkowski sense) plays a crucial role in these scaling techniques. This implies that instead of a utility framework a distance framework is used. This may lead to frictions in case of non-symmetrical psychological distances in all directions or in case of a double-peaked ideal reference pattern.[2]
- Scaling techniques were originally not developed as tools to forecast spatial behaviour. They focussed mainly on cognition and on evaluation of spatial

1) The perceptions or preferences of spatial attributes can even be confronted with actual spatial behaviour by means of adjusted multidimensional scaling techniques for ex ante and ex post analyses.

2) For example, a migration decision may use a favourable employment situation in one place and good environmental conditions in another place as two ideal reference points.

opportunities, so that perception and preference studies received most attention. By linking these studies, however, to objectifiable features of the items, they can in principle be used to predict future spatial processes.

In spite of the abovementioned limitations of perception and preference analyses by means of multidimensional scaling methods, in our opinion these techniques are a powerful tool to deal with spatial choice problems in case of incomplete or even fuzzy information (Nijkamp, 1978). In the next section, the use of behavioural approaches for spatial choices in the framework of human settlements analysis will be spelt out in more detail.

4. Human Settlements Analysis: Methodology

The post-war shifts in residential location patterns have evoked the need of a closer analysis of the determinants of spatial processes. The 'geography of movement' (Lowe and Moryades, 1975) has emphasized that the analysis of spatial developments is equally important as the analysis of a given spatial structure.

An operational analysis of spatial processes may take place from the abovementioned two different points of view, viz. a macroscopic and a microscopic point of view. The macroscopic view aims at drawing quantitative inferences on the determinants of spatial behaviour from observed patterns of spatial development, while the microscopic view attempts to identify the determinants of spatial behaviour from information on individual spatial perception.

In the macroscopic approach a set of aggregate variables describing a certain spatial process (for example, urban-suburban movements) is linked to a set of explanatory variables. Such a behavioural model is essentially based on an aggregate revealed preference approach. By means of appropriate regression techniques one may test and estimate the impact of these variables upon the spatial process variables.

A general formulation of such a spatial process model is:

$$x_{ij} = f(\underline{y}_j - \underline{y}_i) \tag{4.1.}$$

where: x_{ij} = flow from place i to j

$\underline{y}_j$ = set of relevant explanatory indicators in destination j

$\underline{y}_i$ = set of relevant explanatory indicators in origin i

The foregoing model reflects the fact that spatial movements emerge from simultaneous push and pull effects between places of origin and destination (including distance frictions). This model can easily be extended with spillover effects to surrounding regions (cf. Nijkamp, 1977a). In that case the model can be written as:

$$x_{ij} = f^* (y_j^* - y_i^*) \quad , \tag{4.2.}$$

where y_j^* represents the compound set of explanatory variables from both the central region j and its surrounding regions. Assuming a weighted contiguity effect for each region s adjacent to region j, one may write y_j^* as:

$$y_j^* = y_j + \sum_{s \in C_j} \hat{w}_s \, y_s \quad , \tag{4.3.}$$

where C_j represents the set of regions adjacent to j and where $\hat{w}_s$ represents a diagonal matrix with contiguity weights on the main diagonal. On the basis of sufficient data, models of the type (4.1.) or (4.2.) can be estimated via either a cross-section or a time-series analysis.

A serious problem is the fact that the profile vectors y_j and y_i representing a set of push and pull factors should not include too many elements, because a large set of indicators reduces the number of degrees of freedom in a regression analysis and may cause problems of multicollinearity. It is clear, however, that the profiles y should incorporate the most relevant factors of spatial choice behaviour, such as employment conditions, socio-economic conditions, living conditions and distance frictions.

In contrast with the abovementioned <u>explicit</u> macroscopic method, in some macroscopic methods, however, the total push and pull effects are estimated in an <u>aggregate</u> and <u>implicit</u> way, particularly in spatial interaction analyses based on gravity-type or entropy-type models. Assume for example the following entropy model:

$$x_{ij} = A_i \, B_j \, O_i \, D_j \, e^{-\beta d_{ij}} \tag{4.4.}$$

where O_i and D_j represent the given marginal flow totals for the places of origin and destination, respectively, and where d_{ij} represents the distance between i and j. On the basis of spatial flow table with elements x_{ij}, one may estimate the distance friction parameter β as well as the regional push and pull effects A_i and B_j. This implies that the push and pull factors are gauged <u>ex post</u> on the basis of revealed preferences reflected by actual (aggregate) spatial choice behaviour. Such an implicit estimation of attractiveness indicators is often carried out in shopping models, recreation models, residential choice models, and migration models.

A simpler version of (4.4.) based only on pull effects of the region of destination may be:

(4.5.) $x_j = B_j\, e^{-\beta d_{ij}}$,

where x_j represents the total flow toward region j and B_j the implicit attractiveness measure of region j.

The <u>macroscopic</u> observation method has clear advantages: it provides a testable quantitative frame of analysis and uses well-known standard estimation methods. Its aggregate character, however, hampers the inference of specific conclusions about socio-economic groups or regions at a lower scale, so that the results of this analysis have to be used carefully. Consequently, the derivation of policy conclusions from such aggregate models is fraught with difficulties.

As set out before, a <u>microscopic perception</u> method may also be used in order to identify <u>a priori</u> the motives, perceptions or priorities of individuals or groups regarding their spatial choice behaviour. The perception method takes for granted that the subjective judgements of individuals or groups rather than the objective features of a place or region determine the attractiveness of places or regions.

Consequently, the perception analysis is not based on aggragate spatial flow data, but on individual spatial choice and perception data. In this approach, the spatial attractiveness profile can hardly be measured in cardinal units, so that usually these spatial choice and perception analyses are based on a qualitative or ordinal assessment of the elements of an attractiveness profile. Normally, this kind of information can be transformed into ordinal rankings of the values of the perceived attributes or items of the attractiveness profile. For example,an individual attractiveness profile (measured either at the place of origin or of destination) may include the following elements (measured on an ordinal scale):

(4.6.) $$v_i = \begin{bmatrix} \text{availability of dwellings} \\ \text{quality of dwellings} \\ \text{quantity of recreation facilities} \\ \text{degree of satisfactory shopping facilities} \\ \text{social amenities} \\ \vdots \end{bmatrix}$$

These ordinal data can be transformed into metric data by means of the multidimensional scaling techniques discussed in section 3. In addition to a cross-section analysis over a number of individuals, a similar cross-section analysis may be carried out over a set of places or regions. In the first case, one may measure the (inter)personal differences in perceptions or preferences with respect to spatial attributes or items; in the second case, one may measure the perceived (inter)local differences in attractiveness profiles. In this way one may infer conclusions about the most preferred attributes of an attractiveness profile or the most preferred place characterized by a certain attractiveness profile. It is clear that this analysis is extremely useful to identify the metric determinants of evolutions in human settlements systems, the growth and decline of functional urban regions, desurbanization and re-urbanization movements and the like. In the next section, some empirical applications of the preceding macroscopic and microscopic approach will be presented.

5. Application

As set out in section 2, the Netherlands are marked by rather dynamic spatial migration movements during the last decade, such that the original structure of human settlements and functional urban regions has shown a significant change. It was hypothesized in section 2 that the environmental conditions might offer a major explanation for these spatial movements. This hypothesis was tested by means of the following interregional migration model (cf. also Nijkamp, 1977):

$$m_{ij,t} = f\{(l_j^d - l_j^s)_{t-1}, (n_j - n_i)_{t-1}, d_{ij}\} \quad (5.1.)$$

where:

m_{ij} = volume of migration from region i to j

l_j^d = demand of labour in region j

l_j^s = supply of labour in region j

n_j = environmental attractiveness index of region j

d_{ij} = distance between i and j

t = time index

Relationship (5.1.) indicates that interregional migration behaviour is explained from a set of variables, viz. employment, natural environment and distance. It should be noted that n_j is calculated on the basis of an environmental attractiveness profile incorporating as elements among others amount of natural areas, outdoor recreation facilities, and area of lakes and coastal zones. These elements were aggregated to a scalar environmental attractiveness indicator. Clearly, a similar approach could be followed for the labour market indicators. It is evident that this type of migration analysis can be extended in several ways, for example, with social and demographic elements (see, for example, Rogers, 1978).

The aim of this model is to identify the influence of environmental attractiveness indicators upon migration behaviour. This model was estimated for two periods with a time interval of 6 years in order to examine whether a shift in the influence of environmental conditions upon migration behaviour could be observed. The regression outcomes of this model for interprovincial migration flows in the Netherlands for t = 1966 are:

$$(5.2.)\qquad m_{ij,t} = \underset{(483.12)}{4962.90} + \underset{(0.03)}{0.15}\,(l_j^d - l_j^s)_{t-1} + \underset{(371.07)}{715.30}\,(n_j - n_i)_{t-1} - \underset{(2.77)}{20.77}\,d_{ij} \;,$$

where figures between brackets denote the standard errors of estimation. The environmental attractiveness indicator does not provide an entirely significant explanation for migration behaviour (assuming a 2σ confidence interval); all other explanatory variables are significant at a 2σ-level.

The same analysis carried out for t = 1972 gave the following results:

$$(5.3.)\qquad m_{ij,t} = \underset{(539.62)}{6109.30} + \underset{(0.05)}{0.19}\,(l_j^d - l_j^s)_{t-1} + \underset{(429.83)}{948.81}\,(n_j - n_i)_{t-1} - 23.77\,d_{ij}$$

The smaller standard errors of the parameter related to environmental attractiveness indicate that environmental conditions provide a significant explanation for migration behaviour. This result is plausible, because from the end of the sixties onward the environmental movement started to attract much attention in the Netherlands. This shift in environmental preferences and its impact on residential decisions and on settlement patterns is in agreement with the pattern reflected by Figures 1 - 3.

In addition to the abovementioned explicit macroscopic analysis one may carry out an implicit analysis. The latter analysis attempts to gauge the implicit attractiveness of regions or places, given the migration flows to these regions or places. This analysis was also applied to Dutch interprovincial migration flows on the basis of model (4.5.). This analysis was done on a region-specific basis, so that for each region of destination the flows of inmigration from other regions were used as explanatory variables (t = 1972). The following results were obtained by means of a log-linear regression of (4.5.).

province	attractiveness parameter		distance friction parameter	
Groningen	12.41	(1.72)	1.10	(0.34)
Friesland	14.49	(2.48)	1.56	(0.49)
Drente	13.56	(1.97)	1.39	(0.39)
Overijssel	15.13	(2.36)	1.65	(0.50)
Gelderland	13.13	(2.86)	1.12	(0.61)
Utrecht	15.91	(1.33)	1.82	(0.28)
North-Holland	14.32	(1.24)	1.37	(0.26)
South-Holland	15.42	(1.34)	1.51	(0.27)
Sealand	24.51	(2.91)	3.45	(0.54)
North-Brabant	16.77	(2.70)	1.90	(0.56)
Limburg	25.19	(4.62)	3.49	(0.86)

Table 1. Implicit attractiveness parameters and distance friction parameters of Dutch provinces based on interprovincial migration. 1)

The results of Table 1 show that a high attractiveness coincides in general with a high value of the distance friction. This implies that such a high attractiveness may sometimes compensate the distance frictions, especially from the peripheral Southern provinces Zeeland, North-Brabant and Limburg. Inversely, a lower attractiveness may be compensated by a lower distance friction. It is also clear that provinces with a low distance friction (Gelderland, e.g.) or with a relatively high attractiveness and a normal distance friction (Utrecht, e.g.) will attract many migration flows.

An extension of the foregoing implicit analysis can be found in Cesario (1973) who made explicitly a distinction between repulsion and attraction forces of outdoor recreation facilities.

As exposed in section 4, it may also be worth while to apply a microscopic profile analysis, based on interview data of individual persons. In that case, it is normally necessary to employ a multidimensional scaling technique. The case study dealt with here is based on a comparative integrated environmental perception study for the Rhine-delta region around Rotterdam, the Northsea-canal region around Amsterdam, and the Netherlands as a whole, (see Rijnmond, 1977). The Rhine-delta region and the Northsea-canal region are densely populated and industrialized areas which consitute the economic heartland of the Netherlands. Both regions are marked by lack of space, lack of favourable environmental conditions and lack of dwellings. Clearly, both regions have many environmental characteristics in common, but there are some glaring differences (for example, a higher environmental differentiation in the Northsea-canal area, a different demographic structure, and a different socio-economic structure).

1) The results are measured in logarithmic transformations; figures in brackets represent standard errors.

The study focussed on 3 topics, viz. 1) an analysis of the relative importance of environmental attributes perceived by the respondents from the abovementioned 3 areas, 2) an analysis of the degree of satisfaction emerging from these attributes, and 3) an analysis of the willingness-to-pay of the respondents to change the quality of the environmental attributes. In the study, 50 relevant environmental attributes have been distinguished (see Table 2). These attributes were mainly related to 1) ecological variables, 2) indicators for residential quality and direct quality-of-life, and 3) level of amenities. For each of the 3 abovementioned topics, the same set of 50 indicators has been employed. The results of the interviews have been used as input in a multidimensional scaling analysis in order to transform the results in a concise manner into metric information. The scaling procedure employed here has already been described in section 3. The outcomes of the scaling procedure in a two-dimensional joint Euclidean space of regions and attributes are represented in figures 5 - 7[1]. The goodness-of-fit of the scaling procedures appears to be almost perfect.

Fig. 5 represents the results of the differences in importance attached by interviewees to the abovementioned 50 attributes in a two-dimensional metric space. These results demonstrate clearly the relative differences in perception that exist between both the three regions and the attributes, taking into account that a smaller distance between a region and an attribute means that the region concerned judges this attribute as more important. The population of the Rhine-delta (no.2) attaches a great value to the problem of clean air and water, the quality of dwellings, the possibilities for outdoor recreation and the availability of good health facilities. Dutchmen, in general, attach a greater value to social facilities and shopping facilities. Those living in the Northsea-canal area, on the other hand, perceive privacy,noise and costs of dwellings as more important. It seems that the population of the most dirty region, the Rhine-delta,assigns more value to its direct living conditions; the population of the Northsea-canal region, which has better socio-economic characteristics, pays more attention to the "higher" motives in the sense of the hierarchy of Maslow (Maslow, 1954), while Dutchmen in general, who live in a better environmental situation and in a less densely populated area perceive social and shopping facilities as a problem. For this reason, it seems reasonable to interpret the vertical axis of Fig. 5 in terms of degree of urbanization (at the

1) The method applied here is an adjusted version of the Minirsa Program described in Roskam (1975). The numbers 1, 2 and 3 in these figures pertain to the Northsea-canal region, the Rhine-delta region, and the Netherlands as a whole, respectively. The capitals A, B, C,... positioned in the figures stand for the attributes or combinations thereof (see Table 2).

	Fig. 5	Fig. 6	Fig. 7
Clean water	A	U	Z
Clean air	A	U	Z
Clean district	B	W	AB
Youth safety-facilities	F	W	AB
Quality drinking water	E	U	Z
Playing facilities	D	V	AD
Spacious housing	C	V	Z
Public road facilities	F	R	AC
Garden	I	W	AB
Hospital, specialist	F	U	O
Traffic safety	I	W	AC
Architectural structure of district	F	U	AB
Sound-proof housing	H	V	AB
Comfort, quality housing	D	W	O
Dwelling costs	H	R	AD
Public transport	A	U	AB
Environment without traffic noise	I	W	AB
Kitchen/hobby room	D	U	Z
Architecture street	F	U	AC
View on Greenery	F	U	Z
Facilities aged	E	T	AD
Plan of house	F	V	O
Outdoor recreation	E	U	Z
View from house	F	U	O
Parking facilities	F	U	AB
Traffic situation	F	U	AB
Dwelling environment	F	V	AB
Sport facilities	G	W	AD
Balcony	A	U	Z
Environment without Air-traffic noise	I	M	AC
Safe environment	A	U	Z
Family doctor, dentist, chemist	F	W	AB
Type of residence	F	V	O
Parks, public gardens	A	M	Y
Garage	F	M	X
Facilities for youngest children	I	R	AD
Environment without industrial noise	I	U	AB
Secondary education	F	K	Q
Privacy	I	V	AB
Sunning of house, light-fall	D	U	Z
Composition of district	F	N	AC
Distance to/from work	F	N	AA
Outing facilities	D	L	Y
Learning facilities adults	A	L	P
Shops for shopping-goods and durables	F	M	AC
Primary school	I	W	AB
District facilities such as shops	F	K	J
Social contacts	G	S	AC
Sport manifestations	F	K	O
Community buildings	F	S	P

Table 2. List of environmental attributes used in the perception study.[1)]

1)The capitals A, B, C,... refer to sets of attributes with the same position in the metric space of figures 5 - 7.

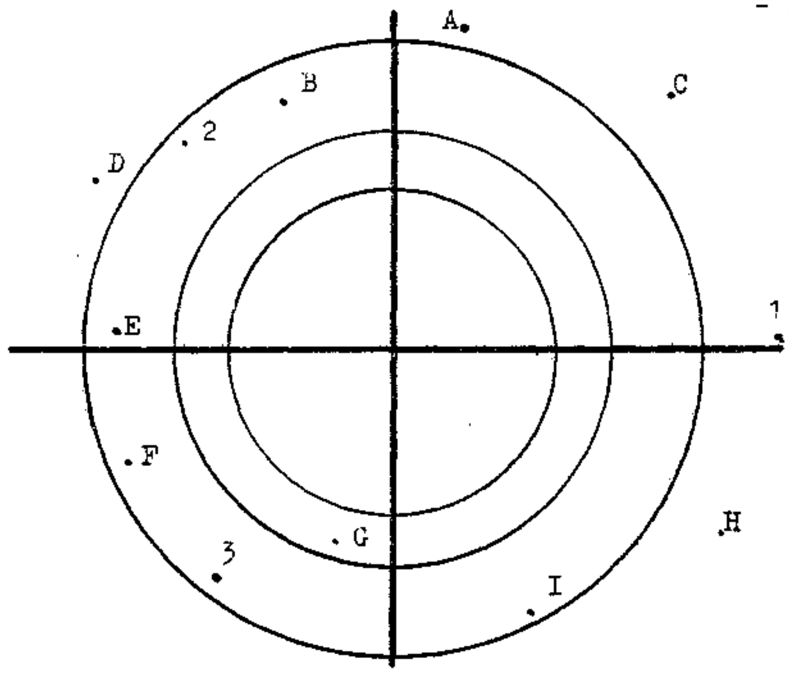

Fig. 5 Joint space of environmental attributes (perceived importance) and regions

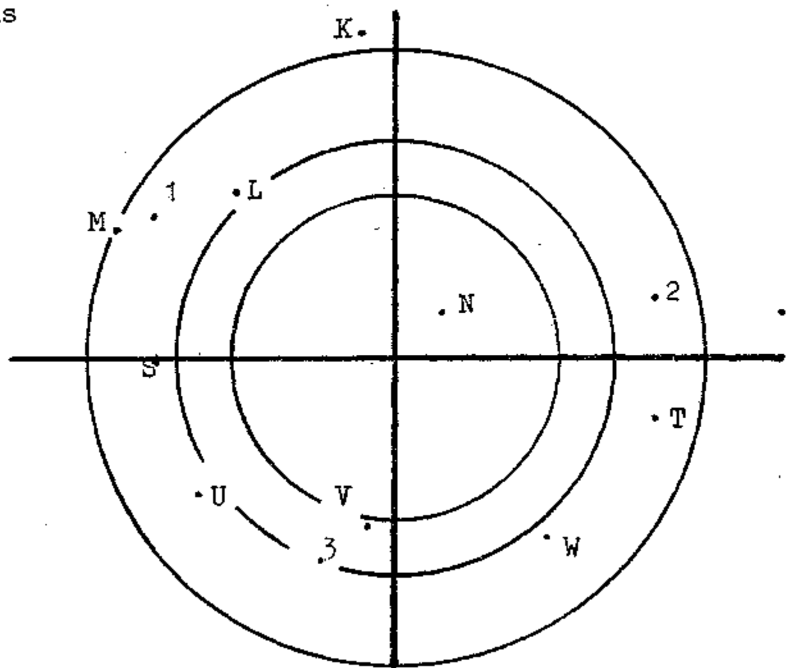

Fig. 6 Joint space of environmental attributes (degree of satisfaction) and regions

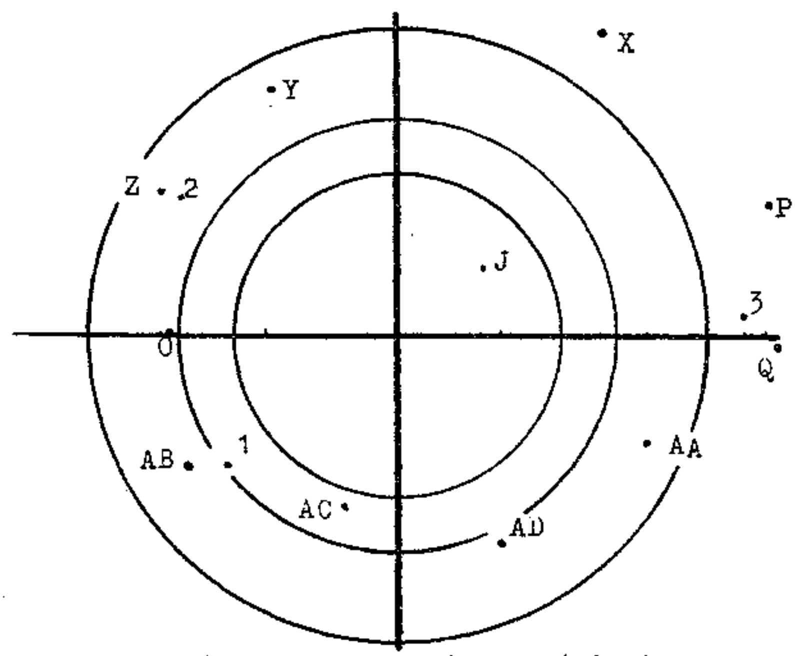

Fig. 7 Joint space of environmental attributes (willingness-to-pay) and regions

upper axis) and of rural conditions (at the lower axis). Similarly, one may interpret the horizontal axis in terms of socio-economic characteristics, where the right part of the axis has better socio-economic characteristics.

Fig. 6 represents the differences in satisfaction between the population of the regions, as far as the actual quality and quantity of the environmental attributes is concerned. Here a smaller distance between a region and an attribute means that a certain region is more satisfied with the attribute. The picture of Fig. 5 is strengthened by Fig. 6. In general, people in the urban regions are more dissatisfied than in the Netherlands as a whole. The Netherlands as a whole has a lower unweighted mean distance with respect to the attributes in the metric space than both urban regions.

The logical consequence for (spatial) behaviour of Dutchmen becomes clear in Fig. 7. The most dissatisfied people(viz. the inhabitants of the Rhine-delta) has also the highest willingness-to-pay (the smaller distance on the metric space means the highest willingness-to-pay) in order to alter their situation, whereas more satisfied people want to contribute relatively less to solve the environmental problems. This attitude (willingness-to-pay) can be seen as the reverse side of the medal: the propensity to migrate. In Fig. 7 the horizontal axis can be interpreted in terms of urbanization, while now the vertical axis can be interpreted in terms of socio-economic characteristics.

Policy Conclusions

From the beginning of the sixties onwards physical planning in the Netherlands has been guided by a set of government documents, the so-called reports on physical planning. The general principles and objectives of Dutch post-war physical planning have shifted significantly, due to changes in political conditions and changes in socio-economic, environmental and demographic conditions. In one of the last reports, the Urbanization Report (1976), several targets for urbanization policy were formulated: a reinforcement of urban functions, a spatial concentration of population growth in a limited number of growth cities and growth centres, and a reduction of mobility to guarantee environmental preservation (see for an extensive discussion, Nijkamp, 1977b). The main issue of the report is essentially dominated by environmental criteria: improvement of the urban quality-of-life and preservation of natural areas and of the 'green landscape'.

It is clear that the control of spatial diffusion of people is a major problem, especially because the forces leading to a significant drop in the number of inhabitants of large agglomerations and to an equal rise of smaller municipalities are very strong. As indicated before, the causes of this diffusion movement emerge mainly from environmental conditions, while the impacts of this movement lead to a further decline of environmental conditions. From the analysis presented in the preceding section it has become evident that indeed quality-of-life is a major component in explaining spatial migration patterns and in controlling a further spatial diffusion of population. In this respect, it is plausible to favour urban renovation and rehabilitation plans in order to create favourable quality-of-life conditions and to implement a strict environmental policy in order to protect natural areas. The same holds true for the improvement of the quality of urban facilities.

The analysis presented above suggests that one of the topics for future research should be a more detailed study of the components of urban quality-of-life, especially as far as the discrepancy is concerned between a desired (demand) profile of urban attractiveness elements and the available (supply) profile of urban facilities. In this respect, an extension of multidimensional scaling techniques may be useful to analyze the urban frictions which induce the flight from the urban agglomerations.

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