On Methodological Problems of Factorial Ecology

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Contents

Ⅰ. Introduction

The term, factorial ecology, was introduced first in 1965 by Sweetser(1965). Since that time, factorial ecology has been developed rapidly and is now coming to be recognized as a distinctive subdiscipline of sociology. Factorial ecology has developed a valuable and unique methodology distinctive from other forms of sociological analysis. However, as factorial ecology has developed a widely used research method in sociological literature, it has been criticized to contain some methodological problems. Thus, the aim of this paper is to explore the problems of factorial ecological methodology and, then, to examine whether the problems are inherent. In this paper methodology is rather loosely termed as an analytical method. It is perhaps necessary to have a brief review of factorial ecology in terms of its basic perspective and methodology in order to clarify the understanding of the main discussion of this paper.

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Ⅱ. Overall View of Factorial Ecology

The perspective of factorial ecology is based on that of human ecology, frequently called social ecology, cultural ecology, or urban ecology. Human ecology has been developed in urban sociology, anthropology, or social geography. There has been more than one perspective in human ecology. There have been also great disagreements as to the proper definition and emphasis of the field. According to the difference in perspective, human ecology can be classified into classical ecology, neo-orthodox ecology, sociocultural ecology, and social area analysis (Poplin 1972, 65–107). Such situations make it extraordinarily difficult to identify the similarities and differences in human ecological perspective. The differences were concerned mainly with the conceptual definition of ecological structure, specification of key explanatory factor influencing the configuration of ecological structure and change, and analytical technique of ecological structure and change (e.g. Park 1925: Burgess 1925: McKenzie 1926: Firey 1947: Quinn 1950: Hawley 1950: Shevky & Bell 1955: Tryon 1955: Buttimer 1968). At a very general level, however, the primary concern of human ecology is with the study of the spatial differentiation of and change in interrelated social variables in relation to their physical and social environment. Theories of human ecology have traditionally shed light on cities rather than on a society as a whole with the assumption that the distribution of demographic, economic, and social phenomena within the city follows regular, recurrent, and predictable patterns (Poplin 1972, 63). In summary, even if human ecological perspective has varied with its schools and even with proponents in the same school, it has focussed on a spatial patterning of city in relation to the forces that give rise to sustain and transform it over time (which is meant by ecological structure and change).

Customarily the term, factorial ecology, has been applied to studies using the city as the focus of study, with census collector's district as an unit of observation and census variables as manifest input. The term, however, can be extended to any study which uses areal units as observation (Rees 1971). This may mean that not only national study (e.g. Ray 1971: Moon 1974) but also cross-national study (e.g. Sweetser 1965: Ray & Murdie 1972) can be included, if their approach is based on an ecological perspective with the use of a factor analytical technique. Like traditional human ecology, the primary concern of factorial ecology is also with the investigation of ecological structure and change in terms of spatial distribution of social variables (e.g. Jonassen 1961: Sweetser 1965: Jones 1965: Murdie 1969: Janson 1971: Haynes 1971: Ayeni 1979, 136–161). Empirical studies of factorial ecology have been also done mostly on city. In actual practice, their studies were concerned mostly with ecological structure (for the bibliography of the studies, see Murdie 1969, 32–38: Timms 1971, 56–58, 264–269: Rees 1971). Factorial studies of ecological structural change have been few (e.g. Sweetser 1962: Murdie 1969; Brown & Horton 1970: Haynes 1971: Hunter 1971: Johnston 1973: Latif 1974: Lo 1975: Janson 1978).

The major differences of factorial ecology from traditional human ecology are as follows (e.g. Jonassen 1961: Sweetser 1965: Jones 1965: Murdie 1969: Janson 1971: Haynes 1971: Ayeni 1979, 136–161). Firstly, factorial ecology pays little attention to physical and social environment in explaining the spatial differentiation of social variables. Social variables covered in factorial ecology may be categorized into two major variables, population and social functions. Population has referred to an aggregate aspects of either individuals or households in terms of their size and structure including demographic and socio–economic background. Social functions, which are performed by the population on a group basis, have included economic, administrative, political, educational, religious, social welfare activity, and so on. Secondly, a factor analytical technique is employed for extracting underlying factors as the dimensions of ecological structure and/or change from a number of empirical variables corresponding the conceptual meaning of the two major variables, population and social functions. Then, each dimension is roughly termed on the basis of the common aspect of the variables that are heavily loaded on each factor. Third, factorial ecologists have no conceptual argument on the definition of ecological structure and its components. Instead, they input data available with the use of a factor analytical technique, then, identify and specify factor structure per se as ecological structure, and define the factors as ecological structural components. These would mean that factorial ecologists are in a position on an ex post facto rationalization for their choice of the conceptual meaning of ecological structure. This position is the same for them in the analysis of change in ecological structure.

In these three respects, factorial ecology is, in a sense, and outgrowth or an extended type of social area analysis (Berry & Kasarda 1977, 122: Ayeni 1979, 17). This is the reason why the origin of factorial ecology is usually traced back to the mid–1950s when the Shevky–Bell scheme of social area analysis emerged (Janson 1980). However, unlike in social area analysis, in most instances of factorial ecology variables are not chosen with the aim of specifically replicating the social area indexes, but rather, of isolating those dimensions which explain as much as possible of the wider ranges of social differentiations. Overall, factorial ecology tries to establish sets of basic dimensions in socioecological differentiation, to research empirical generalizations about these dimensions, and later to develop a theory of socioecological structure and change in terms of the dimensions (Janson 1980).

In factorial ecology, the quest for typologies of socioecological differentiation has proceeded by various routes. For convenience, they may be identified as social space model, profile model, Q–analysis model, and least–distance model (Sweetser 1974). Social space model is an extention of the method used by Shevky and Bell to develop their wellknown typology of urban areas. The typology is created by dividing the census collector's districts into social space. The division may be accomplished geometrically be partitioning the areas vertically and horizontally at arbitrarily selected points or by identifying and making off clusters of plotting points. Profile model offers a profile of factor measures as a characterization of an ecological type. Q–analysis model involves the application of Q–mode factor analysis (based on correlations of cases rather than on correlations of individuals) to indicators chosen as representative of the factorial dimensions. Least distance model uses factor analytical technique to derive as set of fundamental dimensions and scores of these dimensions, and seeks to group the ecological units in such a way as to minimize average variation of criteria scores within groups, while maximizing variation between groups.

Whatever model may be employed in factorial ecology, the analysis of ecological structure and/or change is approached from the use of areal unit (usually census collector's district) as an analytical unit, the collection of aggregate data from each areal unit, the use of census variables as manifest input, and the application of a factor analytical technique to analysis. This methodology is unique and valuable distinctive from other types of sociological analysis, at the same time it has been criticized to contain some problems. Therefore, the discussion on the methodological problems of factorial ecology may be confined to these four areas.

Ⅲ. Methodological Problems Inherent in Factorial Ecology

1. Use of Areal Unit as an Analytical Unit

In factorial ecology, th possible analytical unit of ecological structure and/or change is divided into two categories (Janson 1969). One is concerned with variations within community, actually intra–city variations (that is, aspects of urban spatial structure), and the other with variations among communities or other units, such as communes, counties, and countries (that is, inter–city variations and regional structure in a broad sense). Factorial ecology, most of which have been concerned with intra–city variations, uses census collector's district as a basic analytical unit (e.g. Jonassen 1961: Sweetser 1965 : Jones 1965: Murdie 1969: Janson 1971: Haynes 1971: Ayeni 1979, 136–161). Census collector's district refers to an administratively–defined area as a local decision–making unit of administrative organization either in a whole nation or in a region within that nation. It is usually used as a unit of collecting census data. In factorial ecology such a bounded areal unit serves as a subdivision of total territory, the basis of collecting variables, and site or location of ecological features. A typical procedure is to break up total territory in the manner that no areal unit overlaps another and, then, to compile data for each of these units.

The major problems related to the use of such an areal unit as an observation are the size of areal unit, internal homogeneity, comparability between units, appropriateness of a given boundary system for the study of different set of variables, and ignorance of variability within an analytical unit. To be more specific, in most cases the areal units which are obtained by aggregating properties of smaller units are modifiable, as well as different in size. A set of areas is not the only possible one, but the aggregate can also be constructed in other geographic ways (Valkonen 1969; Cartwright 1969; Janson 1969). Data base are different accoarding to the way to bound areal unit and, as a consequence, different results of study are produced (Valkonen 1969; Janson 1969; Perle 1977). If the areal unit employed does not pose a relatively high degree of social, economic, and demographic homogeneity, the derived data may be unrepresentative of that particular unit as well as basically incomparable with data from other more homogeneous units (Myers 1954). In addition, if a particular boundary system is held constant, it may become obsolete and the units lose their original homogeneity, while if the boundaries are adjusted to community changes, the comparability of units over time is destroyed (Hoiberg & Cloyd 1971). Such an internal homogeneity with respect to one variable must often be sacrificed to homogeneity in another sets of variables (Hoiberg & Cloyd 1971). Furthermore, the data derived form areal unit basis are placed in a position beyond the examination of internal variability within the observed areal unit (Rees 1971).

These devergent problems may be converged on one important issue that each of bounded areal units should not be deviated systematically in homogeneity in order for the unit to be meaningful as an analytical unit. In other words, the territory to be investigated should be divided into sub-areas in the manner that achieves a maximum degree of homogeneity within each sub-area and a maximum degree of heterogeneity among sub-areas. If this is ensured, then, other problems would be trival. Because they are merely either a cause bringing about the variation in the internal homogeneity or a possible result arisen from heterogeneity owing to the size of areal unit. The criterion of homogeneity is not that all the people inhabiting in a given area should be the same, but that the probability of their being of a particular characteristic should be alike in all parts of the area (Timms 1971, 42). Therefore, in any case, for most factorial ecological research it is more appropriate to regard an areal unit as homogeneous if the characteristics of the inhabitants in different parts of the units are similar

(Charnock 1982).

Since the 1950s much effort has been devoted to the investigation of the internal homogeneity of analytical areal unit used either in ecological study in general or in factorial ecology. Empirical research arrived at different conclusions: the larger the areal unit, the more heterogeneous it trends to be (Cowgill & Cowgill 1951); natural area is more homogeneous than census collector's district (Myers 1954); in the empirical research on Massachuestts' ecological structure there is a strong congruence between the results when municipalities were used and when health areas were used as alternative units (Sweetser 1971); the degree of homogeneity of each census collector's district is subject either to the kinds of variables used or to the measurement method of the vaiables (Newton & Johnston 1976) ; even if census subdivision which consist of census districts is reasonably internally homogeneous in terms of a large number of variables, a general trend identified is that census subdivision is noticeably inferior to census district as an analytical unit (Charnock 1982).

However, the question as to the degree to which heterogeneity is to be tolerated has never been posed in a way that would allow an objective solution. No effort has been expended in devising systems of areal units in which the units are thought to be homogeneous. The criteria for adjudging a suitable degree of homogeneity has also not been elaborated. Obviously, such a degree of homogeneity could not ever be approximated in practice. Since no factorial ecological analysis has been reported on alternative areal unit whose homogeneity is ensured, this important technical invariance is largely unexpected.

2. Collection of Aggregate Data

Factorial eclogical data are collected from each areal unit employed. The data collected in this manner are aggregate. In ecology in general, aggregate data are those derived from distribution of attributes or behaviours of individuals on the basis of territorial units (Dogan & Bokkan 1969). The two problems which are quite interrelated–use of areal unit as an observation and collection of aggregate data–are likely associated with the fact that ecological analysis in general employs a framework in which observed phenomena are categorized in terms of bounded territorial units (Hoiberg & Cloyd 1971).

The discussion on the problem related to aggregate data is traced back to Robinson's ecological fallacy. Although Robinson was not concerned with the problem of factorial ecology, his argument of "ecological fallacy" is associated with the issue in that factorial ecology uses aggregate data over territorial units. According to Robinson (1950), in an individual correlation the variables are descriptive properties of individuals, while in an ecological correlation the statistical object is a group of persons. Such ecological correlations are used simply and only as substitutes for individual correlations simply because correlations between the properties of individuals are not available. Consequently, ecological correlations are less valuable than individual ones. Robinson (1950) concluded that: while it is theoretically possible for the two correlations to be equal, the conditions under which this can happen are far removed from those ordinarily encountered in data; from a practical standpoint, therefore, ecological correlation is usually not equal to its corresponding individual correlation; accordingly, ecological correlation can not validly be used without strict qualifications as substitutes for individual correlation.

Almost equally known as Robinson's position are Menzel's and Alker Jr.'s discussions. Menzel (1950) went on to show that ecological correlations may retain their validity even after it has been shown that the ecological and individual correlations clearly differ. Eight types of possible fallacies have been defined by Alker Jr. (1969) by means of the covariance theorem dividing the total individual covariance into within subgroup and between subgroup covariances. Some of the fallacies are especially relevant to research using aggregate data. Of the others the most important one is the "contextual fallacy" in which the individual relationship is incorrectly assumed to be equal in all areas. The discrepancy between individual and ecological correlations can arise from two quite distinct sources, homogeneous grouping of individuals and aggregation bias (Hammond Jr. 1973). The first bias arises when individuals are grouped homogeneously (on the independent variable). This results in a measure of correlation between two variables being necessarily larger for aggregates than for individuals. In contrast, the second bias arises when the independent variable has a contextual effect, or when individuals are grouped into neighbourhoods on the basis of their similarity on the dependent variable. Even if the two sources have opposite implications, what is evident is that, if such biases are present, no inference about the individual relationship can be drawn from aggregate data.

Thus, the problems related to aggregate data refers to the kinds of inferences which are permissible when using aggregate data (Allardt 1969), or more specifically, how can inferences about the behaviours or attributes of individuals be made from aggregate data (Goodman 1959; Blalock Jr. 1971). Such a question is, in consequence, a criticism on aggregate data from the point of view of contextual analysis which attempts to explain an individual behavioural pattern in terms of the social context or milieu in which the individual lives when certain of his/her own social or other personal attributes are held constant (Valkonen 1969).

3. Use of Census Variables

As mentioned in section 2, the main task of factorial ecology is to investigate ecological structure and change. This has been approached from two different ways, yet not so different. One is to stop at identifying and speifying factor structures per se, then, interpreting them as ecological structure or change without examination of their spatial distribution (e.g. Jonassen 1961: Sweetser 1965). The other is to extend the analysis to the spatial patterning of the factor structures (e.g. Jones 1965: Murdie 1969: Haynes 1971: Janson 1971: Ayeni 1979, 136-161). For both approaches, several categories of empirical variables are selected from census for measuring the theoretical variable, ecological structure and/or change. They include the variables of population and social functions being performed by the population such as economic, political, educational, or religious activity, etc. In this sense, factorial ecology is a multivariate quantitative research. Multivariate quantitative research including factorial ecological study are faced with a problem of obtaining a good set of empirical variables for measuring theoretical variables set out. Factorial ecology should give an utmost attention to this problem, because the factors extracted as the dimensions of ecological structure and change are roughly named on the basis of the common aspect of the variables that are heavily loaded on each factor.

In multivariate quantitative research, especially in factorial ecological research, there are some methodologidcal criteria for judging a good set of empirical variables. Firstly, the content of a variable should correspond to the subject of study (Gorzelak 1978). Available statistical data, usually published, refers to different contents such as physical, climate, demographic, social and economic phenomenon, etc. Empirical variables corresponding to the theoretical concept of a study should be retained. Secondly, variables should not be redundant (Janson 1969: Gorzelak 1978). The problem of redundancy arises most often from the variables containing any sub-classes of another variable, or from the variables with the same or almost the same denominator and numerators from different but actually closely related classifications. The example of the former is between "manufacturing establishments per capita" and "manufacturing establishments with 20 or more employees per capita", while that of the latter is between "percentage of males with college education of all males 25 years or over" and "percentage of professionals of all economically active males." Third, in case of comparative study, whether it is the study of an area at another point in time or of two areas at a given time, it is ideal that an identical set of variables in which corresponding variables have the same meaning and classification should be selected. In addition, in factorial ecological study a satisfactory empirical variable should be quantitatively expressed, and comparable and applicable to various areas of different size and type.

In actual practice of factorial ecology, however, many of ecmpirical variables have not conformed to these standards. The practical reason for this is that researchers are restricted by the availability of data, most of which are census data. The limitation of data availability arises from the fact that, even if various authorities such as the central government, state government, cities, and counties publish statistics, their systems lack coordination and clear-cut criteria for defining and classifying items. The technical reason is that since in factorial ecology all variables are construed to be dependent with no clear predictor variables, they can not be precisely evaluated. These situations make factorial ecological study limited in the selection of a good set of empirical variables for measuring a theoretical variable even as other multivariate quantitative studies are faced with. The best solution of this issue attempted by factorial ecological study was to include as many empirical variables as they could do.

4. Application of Factor Analytical Technique

There are two basic models which can be adopted in factor solutions. They are known as "factor analysis" and "principal-component analysis". There are fundamental differences between the two methods. In factorial ecological literature the differences are often ignored: indeed, it is common to confuse the two methods so that the terms "factor" and "component" are used interchangeabley. This paper also uses the terms "factor analytical technique" and "factor", using them rather loosely.

Factorial ecology employs a factor analytical technique for extracting.underlying factors as the dimensions of ecological structure and change from a number of individual empirical variables over each areal unit. In this respect, factor analytical technique offers an alternative approach to the usual geographical and economic systems for territorial areas according to functional criteria. It is also true that, as with other multivariate quantitative techniques, factor analytical technique has some problems which should be carefully determined in the actual analysis of data. Even if the problems have been widely identified (e.g. Janson 1969: Rees 1971: Johnston 1971: Meyer 1971: Hunter 1972: Schwirian 1974: Chojnicki & Czyz 1976: Perle 1977: Janson 1980), they may be classified into two categories. One is mathematical problems included in the calculation of factor loading, communality, and factor score. The other is technical problems in dealing with empirical data.

Apart from the mathematical problems (because these basically belong to the science of statistics), so far as the technical problems are concerned, they may be discussed as follows. Firstly, empirical data should meet some basic assumption before a factor analytical technique is applied. The major assumptions are that: variables used in study should be measured at interval scale (Janson 1969); they should be linearly related to one another and normally distributed (Janson 1969: Rummel 1970, 275–276: Child 1979, 11). These are associated with the equation of factor analytical technique being based on a weighted linear sum of each variable measured at the level of interval scale at least. Either bivariate or univariate normal distribution has the useful property for relationships between variables to be linear (Rummel 1970, 275). Therefore, if normality is maximized, as a consequence, linearity between variables will be maximized. This is the reason why any empirical variables which deviate extremely from normality may be unsuitable for inclusion in factorial ecology, unless they are transformed at least to normality as maximum as possible (for the detailed types and methods of transformation, see Rummel 1970, 271–309). Transformed variables will change original values for cases, but not the order of the cases on these values (Rummel 1970, 273). Rather, they usually improve normality and linearity with the assumption of equal intervals over the range more plausible, thus, increase the validity of variables (Janson 1980). Nevertheless, many variables in factorial ecology have been defined and used on an ordinal level, as well as only a few factorial ecological studies (e.g. Murdie 1969: Janson 1971: Berry & Kasarda 1977, 305–337: Sweetser 1974: Moon 1974) transformed variables for meeting these interrelated assumptions before they were analyzed factorially.

The remaining technical problems are: which model of factor analytical technique to use; how many factors to extract as the dimensions of ecological structure and change; whether to rotate the factors principally extracted, if rotation is considered, which type of rotation to be constructed; and, what magnitude of factor loading to use as the criterion of selecting the composite variables each factor. Bounded up with these operational criteria is the argument of uniqueness or invariance of factor analytical technique.

The problem of which model to use refers to the question of factor robustness which is an indication of the consistency of factors emerging when different models are applied to the same data. Some comparative studies (e.g. Harris 1967: Giggs & Mather 1975: Lo 1975: Conway & Haynes 1977) have shown that the factor robustness is suspicious. A number of models have been evolved according to the rationale upon which they are based (for the detailed models, see Harman 1967, 113–246: Rummel 1970, 101–132), the relative advantages and disadvantages of each model are still very much at issue (e.g. Hunter 1972).

As to the number of factors to extract, only common factors are required and the method is employed with the assumption as to when this will be achieved. Although some criteria for extraction of the best number of factors have been developed (for the detailed criteria, see Rummel 1970, 349–367: Child 1979, 43–54), it is inevitable in empirical study that the final significant number of factors should be fixed arbitrarily according to the meaningfulness or interpretability of the factor extracted.

In regard to rotation, orthogonal rotation has been most often preferred in factorial ecology due to at least three reasons (Perle 1977): mathematical elegance, relatively clear demarcations of underlying domain of interest, and a reasonably simple geometry of factor scores for subesequent analysis and interpretation. These reasons are basically based on the fact that oblique rotation provides for the possibility of correlation among factors, while the orthogonal provides the factors to be uncorrelated with each other. On the other hand, the validity of orthogonal rotation in factorial ecology has been questioned by some students (e.g. Johnston 1971: Rees 1971: Hunter 1972). Some empirical studies of factorial ecology have employed oblique rotation (e.g. Haynes 1971: Walter & Wist 1972). Another group has compared the result to determine a more meaningful system which is simpler and conceptually clear when both rotations were applied to the same data (e.g. Hughes & Carey 1972: Abrahmson 1974: Moon 1974: Giggs & Mather 1975: Lo 1975: Perle 1977). From a theoretical point of view, if unrotated factors are expected to be meaningful, no rotation is to be performed. In general, however, it is true that rotation improves the meaningfulness by simplifying factor structure. What is of importance on this issue is that the meaningfulness as to the decision of acceptance of a factor is dependent on a subjective criterion rather than on an objective measure.

Finally, as to the significant magnitude of factor loading as the criterion of selecting composite variables of each factor, the criterion should be arbitrary according to the overall output of factor loadings in a study. A factor loading of 0.300 or higher was most often used in factorial ecology, whicle 0.350 (e.g. Sweetser 1965) or 0.400 (e.g. Murdie 1969) was sometimes employed. The limit of these magnitudes is arbitrary from one study to another. Several techniques have been suggested as to the decision on what factor loading is worth considering when it comes to interpreting the factors (for the detaild techniques, see Harman 1967, 435: Child 1979, 45–46). Even if they are based on a statistical proposition, they are absent from any adjustment for the number of variables, or the factors under consideration. Or even in the statistical formula which is considering these, the value of factor loading required for significance should be different according to the ranks of factors extracted.

Ⅳ. Conclusion and Discussion

The main concern of factorial ecology is with the investigation of ecolgical structure and change from a human ecological perspective and using a factor analytical technique. As discussed in previous sections, however, factorial ecology has been criticized to contain some methodological problems. The criticisms were given to the use of areal unit as an analytical unit, the collection of aggregate data from each areal unit, the use of census variables as manifest input, and the application of factor analytical technique to analysis. It is true that the result of a study depends totally or partially on how to specify each of these problems. However, these mathodological problesms do not mean that factorial ecology is useless or marginal to scoiology. Because the criticisms are prehaps misled or exaggerated. The evidences of this come from the following.

First of all, the criticism on the use of areal unit as an analytical unit has been focussed on one important issue that the territory to be investigated should be divided into sub-areas in the manner that achieves a maximum degree of homogeneity within each sub-area and a maximum degree of heterogeneity among sub-areas. This issue arises from the bounded areal unit by administrative designation. If this is a constant problem, its effect may be controlled, even if partial, by measurement method of variables and normalization of the variables whose distributions are deviated extremely from normality. Percentage, mean, or rate is preferred to absolute number in the measurement of factorial ecological variables. They are accepted as more or less partial measures of variables on an interval scale level, as well as representing the value of a variable with the effect of areal size having been removed (e.g. Jonassen 1961 : Sweetser 1965 : Jones 1965 : Murdie 1969 : Janson 1971 : Haynes 1971 : Ayeni 1979, 136–161). If the value of variable measured in this manner shows an extreme deviation from normality, data transformation to normality is another partial alternative.

The criticism on the use of aggregate data which is quite interrelated to the use of areal unit has been derived from a point of view of contextual analysis as is mentioned in section 3.2. Although aggregate data collected from areal unit are sources of fallacy or error insofar as one wishes from them to make inferences of the relationship between the behaviours or attributes of individuals, factorial ecology is, in principle, interested not in the inference of individual behaviours or attributes, but in the inference of aggregate ones : Correlations in which the units of observation are areal units are by no means always computed merely as an inferior substitute for the theoretical preferable individual correlations (Duncan et al. 1961, 27). The question of ecological correlation, thus, perpetrates a usage of the term "ecological" in a meaning that has no generic connectin with human ecology (Duncan 1959). Aggregate data are correct as descriptions of the relationships between the areal values of variables (Menzel 1950: Goodman 1959). It is entirely proper to use them in investigations in which area is the fundamental unit of analysis (Hammond Jr. 1973). In every case, ecological perceptual orientation is concerned with the variance between teritorial units rather than with their internal variance (Rees 1971: Robson 1971, 156), or with group properties rather than with individual properties (Schnore 1961). Aggregate data are collected for the application of ecological theory to social structure, not for the application of individual behaviour to social structure. It is logically acceptable that ecological perceptual orientation is fallacious from a point of view of contextual analysis, then, contextual analysis is also fallacious from a point of view of ecological perceptual orientation (Berry 1971): the refusal to treat the collectivity as such ; the attempt to explain behaviour system in terms of individual units whose aggregate values are supposed to be the true behaviour for the collectivity: the admission as the only inference made that individual is a decision-making entity independent of his/her group or context.

Therefore, problems are not necessarily due to the use of a certain type of data but are rather associated with theoretical frame of reference. Although working with aggregate data, one can at least try, if necessary, to have regard for individual and collective levels of relationships, as well as for the relationships between collective and individual variables (e.g. Goodman 1953: 1959). There also exist deliberate but fruitful uses of ecological correlations for arriving at statements about individuals (e.g. Allardt 1969)). If an ecological model is correctly specified and there are no contextual effects of interactions, the result will be the same as those at individual level (MacAllister & Kelley 1983). Therefore, as Clark & Avery (1976) have indicated, it may be said that the dangers of ecological fallacy or error are greatly exaggerated. It may be also said that the real issue does not seem to be the nature of data. This may mean that the two approaches, the ecological and the contextual, should be complementary and necessary for sociology rather than an internecine bickering.

In regard to the use of census variable, it is not expected that census covers all the empirical variables corresponding the conceptual meaning of ecological structure and/or change. It is also true that there is no multivariate analaysis which has no data limitation. And, the technical problems related to the use of factor analytical technique may not mean that the application of factor analytical technique is useless. They should be understood as a methodological limitation or incompletion rather than as a problem. The core of problem may be how to select one of the alternatives which is judged as being most appropriate for one's own research framework and objectives. In a strict sense, the technical problems of factor analytical technique are, in nature, belonged not to ecology, but to the science of statistics. In social science in general, given a particular study goal in theory development, the question regarding analytical technique may be which one is more suitable rather than which one is perfect.

Since the 1930s when human ecological analysis paid a great attention to cities, some extreme objections have arisen: human ecology being marginal to sociology, it is not logically a part of the central subject matter of sociology, or is outmoded (e.g. Boskoff 1949: Odum 1951, 353; Rose 1956, 366: Willhelm 1964: Michelson 1976). However, human ecology falls within a realm of sociology in terms of its framework (Berry & Kasarda 1977, 1S: Mlinar 1978: Janson 1980: Wilson 1984). Factorial ecology, as a part of human ecology, also falls within a realm of sociology (Janson 1980). The theoretical paradigm of human ecology is based on adaptation, growth, and evolution (Hawley 1984). Its position lies in a positive sociology (Wagner 1963) or a multiple-level research (Valkonen 1969) in terms of metholdological rationale, and a macrosociology (Schnore 1961: Berry & Kasarda 1977, 13) in terms of perspective. Since the early 1960s, sociologists have become more cognizant of the value of factorial ecological study and have widely applied to them as both independent and depenent variables. These applications have been done mostly on urban research. It may be because that cities are the central elements in the spatial organization of regional, national, and supranational socioeconomies by virture of the interregional organization in a total ecological field of the functions they perform (Berry & Kassrda 1977, 85). In line with this, a lot of factorial ecology have been applied to regional and intracity variation (e.g. Olsen & Garb 1965: Carey 1966). In addition to ecological structure and change, specific aspects have also been approached from factorial ecological technique with emphasis on crime (e.g. Schmid 1960: Boggs 1965: DeFleu 1967) and other social problems (e.g. Groenholm 1960: Allardt 1964) and on political behaviorur (e.g. Cox 1968: Walter & Wist 1972: MacAllister & Kelley 1983).

Another important value of factorial ecological approach is its application to the study of regional development. The evidences are likely to come from that ecological perspective on regional development may focus on such three specific social contexts of development processes as changes in the level of territorial social organization, the emergence of coherent territorial sectors and their relationships, and the relationship between the level and rate of changes affecting the unit of time in which change takes place (Mlinar et al. 1978). Thus, the result of factorial ecological study can be used as an independent variable with regional research or may be used as a framework for regional or national development.

However, ecological structure does not represent the sum and substance of social structure, but constitutes only a limited aspect whose major concern is with spatial patterning (Blau 1977). It is worth noting that new perspective on urban or regional social structure emerged since the late 1960s and the early 1970s. The new perspective–at once holistic, structural, interdisciplinary, critical, and change–oriented–has variously been designed urban political economy, Marxian urban political economy, new urban social science, new urban sociology, or structuralist urban theory (Hill 1983). The divergences of the new perspective have originated and developed from three lines of critical thoght sharing a common project to reorient contemporary urban and regional studies (Zukin 1980): Frence Marxism, British new–Weberianism, and American radical empiricism, With the increase in such a new perspective on urban and regional social structure, in recent years comparative studies between ecological and the new perspective have been attempted by both human ecologist (e.g. Hawley 1984) and neo–marxist (e.g. Pickvance 1983). If ecological perspective has perceived urban or region as a social laboratory which is meant by a static organism, then the new perspective perceives it as the summary of capitalist contraditions, stranglehold, bottlenecks and other various disfunctionalities.

Therefore, it is true that factorial ecological approach has become more aware of its limitations, and there appear to be an emerging interdisciplinary agreement that there is a continuing–indeed, growing–need for enriched studies that span disciplinary and subdisciplinary concerns for understanding social phenomena in terms of spatial arrangement.

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<국문초록>

요인 생태학의 방법론의 문제점

정 대 연

요인 생태학(factorial ecology)은 요인분석(factor analysis)의 통계적 기법을 적용시켜 사회의 생태구조와 변동을 연구의 대상으로 삼는다. 생태구조는 사회구조의 공간적 분화의 유형이라는 점에서 사회구조 일반론과는 개념적으로 구별된다. 즉, 사회학에서 사회구조 일반론은, 그것이 미시적 관점이든 아니면 거시적 관점이든, 사회구조의 구성단위들을 확인하고 그 단위들 간의 관계의 유형에 초점을 두지만, 그 구성단위들의 공간적 분화의 유형은 관심으로 삼지 않는다. 때문에 사회구조 일반론에서의 구조의 개념과 구별짓기 위해 생태구조라는 개념을 사용한다.

이러한 요인 생택학이 생태구조와 변동을 연구하는 모델은 사회 공간 모델, R-모델, Q-모델, 최소거리 모델 등 다양하다. 그러나, 어느 모델로 분석하든 요인 생태학에서 생태구조와 변동의 분석방법은 연구대상 지역(특정 도시, 농촌, 혹은 전체국가)을 선정한 후 그 지역을 다시 여러 하위 지역단위들로(주로 센서스 조사 단위별로) 나누어, 그 하위 지역들을 단위로 하여 집합적 자료를 수집하고, 그 집합적 자료는 주로 센서스 자료에 의존하고 있고, 이 자료들에 요인분석의 통계적 기법을 적용시킨다. 때문에, 관찰단위로서의 하위 지역단위들 간의 동질성의 문제, 집합적 자료가 갖는 사회학적 의미, 센서스 자료가 생태구조의 개념적 변인들을 망라하고 있는가라는 자료의 한계성 문제, 그리고 다양한 모델의 요인분석 기법들 가운데 어느 것을 어떻게 적용시킬 것인가라는 기술적 문제가 곧 요인 생태학이 안고있는 방법론적 문제점들이다.

이 글은 요인 생태학의 방법론적 문제점으로 논의 되어온 위의 4가지 문제들이 과연 타당한 논쟁인가를 비판적으로 검토함으로서, 사회학적 방법론으로서의 요인 생태학적 방법론의 위치와 그것의 의미를 검토하였다.