Some methodological issues in the measurement, analysis and evaluation of peasant farmers' knowledge of their environment

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PREFACE

This report examines some of the methodological problems involved in the measurement and evaluation of peasant farmers' knowledge of their environment. It is based on the case study which is the subject of MARC Report No. 4 entitled *The utility of the Nigerian peasant farmer's knowledge in the monitoring of agricultural resources.*

Although the methodology of evaluating the communication of environmental information does not form a direct part of the MARC research programme, it can be an important factor in the design of monitoring systems, particularly in developing countries. It is for this reason and because of its close interrelationship with MARC Report No. 4 that we publish it in the MARC series.

Much of the argument presented is at present speculative and in the early stages of development. The report is therefore published at this stage as a Research Memorandum in order to stimulate as much comment and discussion as possible.

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1.0 Introduction

This paper examines some of the problems involved in measuring and evaluating peasant farmers' knowledge of their environment and is an extension of the work of Barker, Oguntoyinbo and Richards (1977). That study presented a case for the utilization and inclusion of the perceptions of peasant farmers in the process of monitoring environmental change. Here, the problems of eliciting and evaluating this type of information in methodologically sound ways are discussed, drawing on earlier work in both ethnoscientific Third World studies and conventional behavioural research.

A theoretical rationale and a related methodological procedure are proposed to provide solutions to some of the measurement problems which arise when eliciting information. The methodology focuses attention on the structure and content of farmers' knowledge and, in this respect, their environmental images are the keys as to how knowledge is conceptualized. The last part of the paper looks at the problem of choosing suitable techniques to represent and model the images in a way that demonstrates the ability of the imagery to explain and cope with environmental change.

Thus the purpose of the paper is to introduce and review one possible research methodology for this type of work, in the knowledge that further evaluative work will be necessary before detailed practical research programmes, designed to accelerate social science inputs to environmental monitoring in the Third World, can be put forward.

Barker *et al.* (1977) in their case studies of the Ikale and other groups in western Nigeria showed that peasant farmers were a potentially rich source of ecological information, supplementary to that retrieved from more expensive scientific sources. Further, their interpretations of changes were often sound. For example, not only were farmers able to identify *Zonocerus variegatus* as a grasshopper pest from field specimens and report the damage it did, but also many were aware of the seasonal relationships between its appearance and rainfall, its affinity for the weed *Eupatorium odoratum*, and the way the grasshopper tended to spread from neighbouring weed thickets. Several farmers had correctly anticipated pest control strategies likely to emerge from scientifically controlled research, for example, by identifying and digging out egg-laying sites or destroying *E. odoratum*. Direct problem-reporting by farmers was seen as an *additional* information flow to research establishments and environmental monitoring agencies during the early stages of a specific project rather than as an *alternative* to controlled scientific investigation.

2.0 Peasant farmers' knowledge: its relation to ethnoscience and environmental images

It is generally assumed that an individual's behaviour can be related to his particular environmental image. Despite this assumption, the relationship between a person's own image, the meaning of the image to him, the structure of his image, and the way it *actually* affects his behaviour are highly complex issues that are still only partially understood. Consequently, the fundamental problems to be tackled in assessing the ways in which peasant farmers conceptualize and

structure their knowledge are: how can the information be elicited with a minimum of distortion or bias; and how can the images be represented so that useful and interesting components can be isolated, evaluated and passed on to research establishments or monitoring agencies, to be ultimately used to help provide improved environmental management practices.

The case study mentioned above was part of a much larger project (Richards 1977) and measurement of people's attitudes to their farming problems had to be limited to questionnaires. Thus inferences about the form and content of their environmental images, which lay behind the empirical problem-reporting, were speculative. In general, however, while farmers' evaluations of problems and the associated imagery are partly idiosyncratic, arising as they do from personal experience, they also reflect common attitudes and beliefs of the ethnic group to which they belong. There are interesting possibilities here for a fruitful cross-fertilization of ideas between studies in ethnoscience and recent developments in behavioural geography and psychology, since they appear to share several methodological problems.

Ethnoscience is the study of shared cultural patterns of cognition and belief within an ethnic group (Knight 1974; Warren 1975). This sharing of cognition performs an important role in organizing and transmitting cultural knowledge through the group. Research into environmental images held by individuals would undoubtedly aid investigation and elucidation of the group imagery, and *vice versa*.

An example of convergence between ethnoscience and behavioural geography exists in the growing consensus about the nature of the rapport between interviewer and respondent in investigations into cognitive structure. It is possible to characterize the approach to obtaining attitude information as having two poles. At one extreme, respondents are allowed to define and supply their own attitudes to topics such as farm problems, and also to define the problems themselves; at the other, an interviewer might present a farmer with a pre-selected set of topics, such as categories of farm problems and attitudes to them, from which the respondent chooses those which best describe the way he feels. Thus the farmer can either be part of an open-ended exchange, or participate in a highly structured interview or questionnaire. Both styles have well-documented advantages and disadvantages (Oppenheim 1966). Two of the main disadvantages are, in the first method, the difficulty of *post hoc* coding prior to analysis of the verbal responses and, in the second, the introduction of bias by the interviewer through unintentionally putting ideas into people's heads. In fact, it is usually desirable and necessary to develop intermediate procedures.

However, in both ethnoscience and behavioural geography, work on environmental perception and cognitive structures is tending to favour the former approach. Warren (1975) argues that the technique of ethnoscience

> "involves research which is conducted through the indigenous language, the design of a series of culturally appropriate questions, the correlation of specific answers to specific questions, and the delineation of the indigenous values, classifications and categories

within particular domains of knowledge (e.g. agriculture, botany, zoology, medicine).

Using these formal linguistic techniques which have been developed within the last decade, the anthropologist may serve as a facilitator in the initial communication linkage between the local group and the agency through which the problem was initially articulated."

The argument is that it should be the people in cultural groups and not outsiders who should define their own nomenclature and folk taxonomies, and describe and represent their own cognitive systems of knowledge.

Similarly, Hudson (1974), who has studied the structure of shopping images in Bristol and the attitudes of local people towards new towns in Durham, argues that unstructured interviews are better when trying to measure environmental cognition. Interestingly, Hudson has recently started to record his interviews, a back-up facility that is common in Third World research.

In the context of farming problems, there are additional advantages to flexibility within an interview. Since one purpose specifically is to seek 'new', 'unexpected' or 'early warning' data from shrewd empirical observations, it is desirable to give the interviewee maximum freedom of expression whenever such information is forthcoming, and also to allow the interviewer freedom to probe skilfully the deeper points that appear particularly relevant.

3.0 The problem of representing images and cognitive structures

Knight (1974) characterizes thought processes about the environment as having three fundamental components. *Perception* is the immediate sensory reception and mental awareness of environment; *cognition* is the more enduring patterns of thought and belief arising from enculturation and experience; and *attitudes* give meaning and preference to perception and cognition. An *image* is defined by Harrison and Sarre (1971) as an individual's mental representation of parts of external reality that are known through any type of experience. A growing literature, for example Downs and Stea (1973), indicates the increasing interest in the relationships between the structure of images and their influence on environmental behaviour. For example, it appears that images have both spatial and non-spatial attributes, and geographers have turned their attention to the study of mental maps (Gould 1966) and cognitive mapping processes.

The basic assumption of all this behavioural research is that there are underlying ordering principles, perhaps unique to each individual, which form the basis of cognition, even though the individual may be incapable of verbalizing them. These principles tend to be conceptualized by research workers for convenience, as reference axes or dimensions representing particular attitudes, and along which perceived elements of the environment can be located. Since people have many attitudes, each person has numerous axes which exist in a multidimensional psychological space. Within this space, perceptual data are organized or 'mapped' by him, and the whole represents his image or cognitive structure of the real world. His picture of the real

world, however, is not static: its form and content change with time, and his own actions often give rise to new perceptions and thus modify his image.

The study of peasant farming in western Nigeria (Barker *et al.* 1977) produced evidence to suggest that such underlying ordering principles lay behind particular statements about farming problems. Farmers were asked to list their problems and to give the reasons for these problems. This was a simple and quick method of obtaining information, yet 'problem' and 'explanation', although intuitively obvious concepts, seemed far from clear in this context. 'Problem' and 'explanation' are highly constrained by their cultural milieu.

The descriptive verbs used in answering the farm problem questionnaire suggested that underlying dimensions of environmental cognition might be inferred from the response of Nigerian farmers. An example of such a dimension might be "competition for my food supply by animals and insects", which is suggested by the problem statements "insects attack yams" or "ants destroy cassava". Farmers could then rank animals and insects with respect to this dimension. Similarly, the discovery that *Z. variegatus* was a valuable supplement to diet might reflect a dimension of 'edibility' or 'utility of animals or insects'. If dimensions like these are common in an ethnic group, i.e. are part of its ethnoscience, environmental managers implementing a particular policy, such as the introduction of an agricultural innovation, would need to understand the configuration of these dimensions in order to interpret farmers' likely reactions and attitudes to crops, flora and fauna in their environment. An example of potentially conflicting views between farmers and environmental managers is given in Barker *et al.* (1977) where the grasshopper *Z. variegatus* was a valuable emergency food source, particularly amongst Alayi farmers in southern Nigeria, and children were the main beneficiaries.

Wager and Gay (n.d.) in a more rigorous study of the Kpelle people in rural Liberia found similar underlying dimensions to cognitive structures. Their respondents were asked to complete 20 sentences, each commencing "I know that . . .", in any way they wished. One purpose of the study was to classify responses and then produce an aggregate picture of Kpelle ethnoscience. It was found that two common dimensions underlying the statements that were made were 'traditional-modern world' and 'good-bad', and at a later stage in the analysis it was possible to classify the statements as 'good-modern', 'bad-modern', 'good-traditional' and 'bad-traditional'.

4.0 Personal construct theory and elicitation techniques

4.1 Theoretical basis

Personal construct theory (Kelly 1955; Bannister and Mair 1968; Hudson 1970) is concerned with the way people evaluate the elements of their environment. 'Elements' in the context of peasant farming could be animals, insects, crops or farm problems. The term attempts to isolate and represent the nature of underlying mental constructs or dimensions which a person uses to make evaluations about the elements. Individuals react to how something appears to be to them, rather than how it is in reality. Thus information is used in a way which

is 'objective' or 'rational' to an individual and not necessarily in any 'real' sense. In effect, therefore, personal construct theory uses the model of the behaviour of the scientist as an analogue for human behaviour in general. Individuals make observations of the real world, set up conceptual models of reality to interpret these observations, and use these interpretations to set up hypotheses of future events upon which they base their decisions about future actions. Peasant farming is a suitable context in which to apply such reasoning since behaviour is inescapably based on past experience and future expectations.

The ideas embodied in personal construct theory are entirely consistent with the ethnoscientific perspective. The conceptual models of ordinary people in industrialized cultures are likely to be conditioned by and have isomorphisms with the scientific and technological values of an industrial society. The mental images of people in other cultures, such as the Ikale of western Nigeria, are patterned by a different view and different experiences of the world which are to them no less rational or 'scientific'.

Given these propositions about how people behave, what is the nature of these constructs? Clearly, this is crucial to the problem of attempting to devise ways of measuring constructs. Kelly (1955) argued that people interpret the elements of their environment by categorizing them as either similar to or different from each other in various important respects, called constructs. Constructs, or dimensions, are thus bipolar scales which are developed in the process of experiencing and interpreting environmental stimuli, and each person has his own *system* of constructs.

A construct is simultaneously a basis for similarities and differences between things. There are two important ways in which they are distinguished from concepts. A construct excludes certain things as being irrelevant to the contrast involved and also has a limited range of applicability; this is not the case for concepts. An example is the distinction between *two concepts,* 'black' and 'white', which to any particular individual might represent *one construct.* As a concept, 'black' is only contrasted with 'not black' and 'white' with 'not white'. However, if two stimuli 'coal' and 'food value' are introduced, both would be classified as 'not white' with respect to the concept 'white', but an individual judging them in terms of his construct 'black-white' would consider 'food value' irrelevant, although it might have meaning on another construct.

Similarly, a construct has a limited range of applicability to a given person. Bannister and Mair (1968) supply a useful example:

> "Two people may use the distinction 'kind-cruel', but one may limit its use to describing characteristics of people's behaviour in relation to himself, while the other uses it more broadly to include natural phenomena like the sea, the weather, and his fortunes in life. They may use a similar discrimination, but employ it with very different ranges of convenience."

Constructs not only allow the organization of events by making discriminations between them but permit and embody a number of implicit predictions about the events, which are determined by the linkages and interrelationships with other constructs. Bannister and

Mair continue their example:

> "However, the use of the construct 'kind-cruel' to order certain experiences with people, does not merely allow a person A to be categorized as kind and person B to be classed as cruel. By describing A as kind, we immediately imply a number of predictions about his future behaviour in relation to ourselves or others. We may expect A to lend us money, to look after a sick relative and be likely to consider other people's feelings, whereas B may be expected to disregard other people's needs, kick us in the teeth when he gets the opportunity and leave old ladies in the middle of the street. All these subordinate constructions are anticipations deriving from the original construction of the subject on the dimension 'kind-cruel'."

In this example the interrelationships between constructs permit an individual to make predictions and anticipations by categorizing A and B as kind or cruel. Thus it is important to examine an individual's personal construct *system* rather than constructs in isolation. This, in turn, presumes an eliciting methodology that looks at the total set of constructs with which a person construes a set of stimuli.

Another point relates to a criticism of the nature of constructs as dichotomies rather than gradations, i.e. as black and white, rather than as greys and whiter shades of pale. Kelly himself anticipates this point and provides a lucid clarification of his position:

> "But while constructs do not represent or symbolize events, they do enable us to cope with events, which is a statement of quite a different order. They also enable us to put events into arrays or scales, if we wish. Suppose, for example, we apply our construct to elements, say persons, or to their acts. Consider three persons. One may make a 'good-bad' distinction between them which will say that two of them are good in relation to a third, and the third is bad in relation to the two good ones. Then he may, in turn, apply his construct between the two good ones and say one of them is good with respect to the other formerly 'good' one and the one already labelled 'bad'.
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> This, of course, makes one of the persons, or acts, good in terms of one cleavage that has been made and bad in relation to the other. But this relativism applies only to the objects; the construct of good versus bad is itself absolute. It may not be accurate, and it may not be stable from time to time, but, as a construct, it has to be absolute.
>
> Still, by its successive application to events one may create a scale with a great number of points differentiated along its length. Now a person who likes greys can have them — as many as he likes."

In conclusion, perhaps the most important feature of Kelly's ideas is that they form an integrated methodology. The theory about the way people behave (personal construct theory) can be intimately linked to the elicitation techniques used to implement it; it was noted earlier that in the context of farmers' environmental knowledge it was crucial to relate measurement procedures with the way they evaluated environmental change.

4.2 Repertory grids

A repertory grid or matrix represents the respondent's *system* of personal constructs. The columns of the matrix are the *elements** and the rows are the discriminators or *constructs* that he uses to categorize the elements. In the context of peasant farmers' environmental perception, the elements might be pests, or farm problems in general, and could be provided by the respondent, the interviewer, or by a combination of both. In a study of peasant farmers' problems it would be of value to let the farmer himself define his problems, either during the interview or from an earlier questionnaire survey in which he participated. Alternatively, if the elements were pests, it would be useful to include automatically those of direct research interest and let the farmer add others which he thought were important.

During an interview designed to elicit a repertory grid, the elements are presented in threes, either randomly or in a pre-arranged way. It is sometimes called triad sorting and is similar to the technique employed by Wager and Gay (n.d.). This particular way of implementing the theory, i.e. by generating constructs from elements presented three at a time, is the crucial advantage of the methodology. It derives from Kelly's definition of a construct as:

> "a way in which two things are alike and by the same token different from a third."

Presenting elements three at a time permits the respondents to distinguish important ways in which two are similar and also different from a third. Consequently, the way in which constructs are defined is both empirical and operational (Lundeen 1972).

When respondents are given elements in threes, they are expected to name two elements which are similar to and at the same time different from a third. The discriminator they use in making this decision, the construct, usually takes the form of two adjectival opposites. These bipolar opposites are assumed to reflect a particular construct, and as many different constructs as the respondent feels important are obtained for each set of three elements. Elements are presented to respondents in sets of three until no more constructs are forthcoming, or until all the triadic combinations are exhausted. In the course of the interview, one would sometimes expect the same constructs to be used for different combinations of triads.

In order to clarify these ideas, an example below illustrates some of the main points in the procedure. Although it represents a hypothetical interview with a peasant farmer, it is based on the types of responses given in the Ikale study. Suppose that there are three elements, *Z. variegatus,* rodents and termites, and that the respondent is asked to say in what ways two are similar and one is different in terms of their farming problems. The farmer might say that termites and *Z. variegatus* are important and rodents are unimportant, that rodents and termites are a problem all the year round whilst *Z. variegatus* is a seasonal problem, and that he eats *Z. variegatus* and rodents but not termites.

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*not to be confused with 'elements' as used in matrix algebra, i.e. the values in the body of the matrix.

Thus the three constructs or discriminators, 'important-unimportant', 'year round-seasonal', 'eats them-does not eat them', are elicited from this farmer using this combination of elements. Note that a different farmer might have produced more, the same number, or less for the same three elements.

From these first three elements and their associated constructs, a grid can be drawn up, for example, in the following format:

	Z. variegatus	rodents	termites
important-unimportant	1		1
year round-seasonal		1	1
eats them-does not eat them	1	1	

In this example the scoring procedure adopted is simply presence or absence, but more sophisticated ranking and numerical techniques have been developed (Bannister and Mair 1968). Next, three more elements from the total set are presented to the farmer, such as *Z. variegatus,* weeds and termites, and he is asked to repeat the procedure. Possibly some of the same constructs are cited, together with new ones, and these are added to the grid. The interview continues until all combinations of elements have been exhausted, and the repertory grid for that individual has been completed. Different people produce different constructs for each combination of elements, and probably a different total number of constructs. If the strategy requires that farmers cite their own set of elements at the beginning of the interview, they are also likely to produce different total numbers of elements. In this example, the elements were farm 'pests' or problems, but an equally valid strategy might have been to make the elements farm crops.

One problem in administering an interview is that it can be very time-consuming; Hudson (1974) reports two hours per interview and, consequently, the procedure would perhaps need amending in a Third World study. Thus, although grids might seem impractical for a large sample, they might provide invaluable follow-ups in small numbers to a large questionnaire survey. Hudson adopted a similar strategy in his analysis of the learning processes involved in students' shopping behaviour. In an environmental monitoring context, there would be positive advantages in being highly selective in the choice of farmers for repertory grid tests, using those who had provided interesting and unexpected insights in the initial survey. Further, a selection procedure would be more productive than randomly choosing farmers for repertory grid tests, if judged in terms of the need to provide useful monitoring data.

In conclusion, repertory grids form a flexible method of evaluating and eliciting mental constructs, which leave much to the inventiveness of the researcher with respect to the problem in hand. Hudson, an active and innovative worker himself in this field, succinctly summarizes their utility as:

> "a flexible method of allowing people to structure their images of reality in their own terms (within the assumptions of the method itself) rather than forcing people to reply in terms of concepts supplied by the researcher."

5.0 A comparison of techniques for analysing repertory grid data

In any individual's system of personal constructs, superordinate constructs are more important than subordinate ones. A superordinate construct is one which includes other constructs as its elements. A construct is subordinate if it is included as an element of a superordinate one. For example, 'damages crops-harmless' might be a subordinate construct which is subsumed by a superordinate construct 'good-bad'. Construct systems are thus hierarchic in that subordinate constructs can exist as elements within superordinate ones.

A repertory grid can contain superordinate constructs explicitly, i.e. they are named by an individual, or they may be hidden such that several named constructs reflect different aspects of an unnamed one which was not brought out by the grid method. Consequently, one of the aims of analysing repertory grid data is to try to determine the nature of a person's superordinate constructs, since it is assumed that they are basic to the structure of his environmental image.

In addition to individual mental images of the environment, there are also group views which form part of an ethnoscience. Thus common constructs, whether superordinate or subordinate, might exist between farmers of the same ethnic group that can be interpreted as part of the consensus view of the environment. Also, some farmers would have constructs unique to their own experience and personality and it would be useful to distinguish these from more general ones where interest lay in particularly perceptive farmers.

In general, the techniques which can be used for these analytical purposes fall into two major divisions; one based on the general factor analysis model, and the other on multidimensional scaling (MDS). Both are used as methods of simplifying complex data sets and attempt to reduce a multivariate data set, such as a repertory grid, to its basic structure. Their aim is to retain as much of the information from the original data as possible. Further, it is assumed that the underlying structure of data in this reduced form can be labelled and interpreted.

Factor analysis techniques have been widely used in many fields on large data sets; in geography, for example, Berry (1966), King (1969) have used them as has Rummel (1970) in International Relations. The applications have been in both structural and behavioural research. In the context of personal construct theory, following Bannister and Mair's (1968) review, behavioural geographers such as Hudson (1974) have applied factor analysis techniques directly to repertory grids. In contrast, MDS, a relative newcomer to behavioural geography (Gould 1970), has not been specifically linked to personal construct theory although it has been used in several ethnoscientific studies (Wager and Gay, n.d.).

Whilst factor analysis is often used inductively to search for order in large data sets, it is more correctly applied when specific hypotheses about the underlying characteristics of the data structure are to be tested, since its application assumes that the variability in the data can be separated into common and unique components: that is, for each object of study measured over a set of variables, the joint variation in some of the variables can be represented as a set of common 'factors' or hybrid variables. Thus, each original variable correlates or 'loads' onto these new underlying factors by large or small amounts, depending

upon how far it is typical of that factor. The factors can be represented as right-angled axes in a multidimensional space, and it is possible to rotate these factors mathematically to new positions. This is done to redistribute the variance between factors, according to some predetermined objective such as attempting to maximize the correlations of as many of the original variables as possible with only one factor, in order to assist interpretation.

In general, a research strategy which uses a factoring technique involves several subjective decisions in the form of choices between alternative courses of action during the analytical procedure. Different combinations of decisions can produce substantially different results from the same data. For example, several different mathematical models, such as principal components analysis, factor analysis and direct factor analysis, and several different rotation procedures are available (Rummel 1970). Consequently, it is necessary to devise a strategy which is closely related to the requirements of the research problem. Factor analysis as a technique tends to suffer in application through the versatility of the options available, although the same will probably become true of MDS approaches as inventiveness of strategy improves.

In relation to peasant farmers' perceptions, a weakness of factor analysis models is that they assume that the relationships between variables in the original data are linear. However, there is little evidence to support such an assumption about attitude data, or another made by factor analysis that the data belong to multinormal parent population distributions. On the other hand, MDS makes no such assumptions about data, and can operate on measurements made at nominal, ordinal, interval or ratio levels. Further, it is reasonable to suggest that decisions people make in judging things and assigning values do have meaning in an ordinal sense (i.e. a person can make sensible rankings) but they have more difficulty in assigning meaningful and comparable numerical values along an interval or ratio scale. Consequently, there seems to be a case for using MDS techniques on attitude data, such as farmers' repertory grids, because of their less restrictive assumptions.

MDS, like factor analysis, attempts to describe and summarize in a quantitative manner, the underlying structural properties of a data set in terms of a predetermined minimum number of dimensions. Also, like factor analysis, there are sometimes problems in interpreting the meaning of the dimensions produced. However, MDS is manifestly different in the mathematical way the dimensions are produced. Whilst factor analysis creates hybrid variables or factors from linear combinations of the original variables, MDS uses information expressed as similarities or dissimilarities between variables (or attributes) and then utilizes the ordinal properties of these similarities. Given a set of similarities between points in a multidimensional space, it is possible to obtain the projections of the points on any arbitrary set of right-angled axes. This is, in essence, what MDS achieves and the mathematical procedures whereby it can be done are described in Torgerson (1958), Kruskal (1964) and Guttman (1968). Obviously, similarities can be derived from measurements at nominal, ordinal, interval or ratio scales (Sneath and Sokal 1973), and hence its potential utility with

repertory grid data.

An intuitive example of the utilization of MDS is to determine the structural properties of data which consist of a set of road distances between towns. In other words, given a set of similarities (i.e. distances), how can these towns be described and located within a minimum number of reference axes or dimensions? Here, the MDS procedure would almost certainly produce a two-dimensional solution which could be interpreted as latitude and longitude. The locations or co-ordinates of the towns produced by MDS do not reflect *actual* geographical positions with respect to each other since road distance is not identical to straight line distance on a map. It would, however, be very similar to the actual spatial distribution, the distribution produced being analogous to that formed by stretching a real map differentially, so that each road distance is straightened out.

Whilst this example is somewhat obvious in terms of its results, the utility of the technique is enhanced when the space involved in trying to 'map' or locate items is more complex than a geographical plane, as would happen in trying to represent farm problems or pests in a psychological space. Suppose a farmer's repertory grid of n elements and m constructs were to be analysed using an MDS technique. The grid is a model of his personal construct system in which all the n elements are located in an m dimensional space whose axes are the constructs. MDS seeks to reduce these m dimensions to a minimum, subject to certain objective criteria about information loss.

The first step is to calculate a matrix of similarities between all pairs of constructs over the set of elements. The similarity measures used would depend upon the procedure devised to produce the information contained in the grid. The MDS technique will then provide a mapping of all grid elements in a space defined by a minimum number of right-angled axes or dimensions, which, as in the case of a comparable factor analysis, might be interpreted as superordinate constructs of the environmental image.

If the elements are mapped into a set of superordinate constructs derived from either a factor analysis or MDS, and a classification of them is sought, groupings may not be obvious from visual inspection. Consequently, it might be necessary to apply more objective clustering methods to achieve this as a supplementary step in the research methodology. The range of techniques available is not discussed here, but see Barker (1974, 1976), Sneath and Sokal (1973).

6.0 Conclusions

This paper has considered the problem of measuring attitudes and conceptualizing people's images of the environment. The discussion was related throughout to a specific research field, the utility of peasant farmers' environmental knowledge in contributing to systems for monitoring ecological change, since it is intended to take up the proposals contained in Barker *et al.* (1977).

Both ethnoscientific studies and recent work in behavioural geography and psychology are concerned with the representation and evaluation of people's cognitive structures of the environment, and they share common methodological problems. Consequently, an

approach to eliciting information from peasant farmers is envisaged which incorporates features of both since it is necessary to interpret knowledge within the context of their environmental images. In particular, the use of personal construct theory and repertory grids is a valuable starting point because of its strong theoretical underpinnings, an integrated methodology, and appropriate elicitation techniques. In turn, the use of these methods in a Third World context could be strengthened by incorporating some of the techniques used in ethnoscience, such as multidimensional scaling and careful lexicographic compilation of folk taxonomies for possible use as grid elements. The last two sections of the paper have briefly summarized personal construct theory and repertory grids, and some of the issues surrounding the application of MDS techniques and factor analysis in representing farmers' environmental images.

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