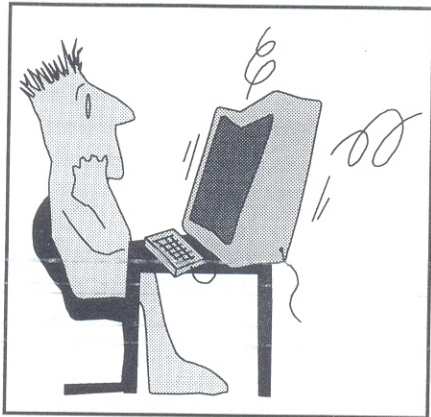

PROBLEMS AND METHODS OF ENVIRONMENTAL RESEARCH

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ABSTRACT

The increasing understanding of environmental research issues are relevant to housing, architecture and planning studies. It is true that researchers are faced with problems related with conducting a research, analysing data and presentation of report for useful readership and consultation. Correlating the right research technique and methodology is an essential tool for a successful research conclusion. It is the aim of this paper to highlight some of the problems faced by researchers and to outline methods which can be used in environmental research. Although research presentation is equally important part which makes for the success of any research report, this is beyond the scope of this paper.

INTRODUCTION

Each professional field whether it is in architecture, housing or planning has its own analytical tools which are part of parcel of its professional baggage. These techniques deal with substantive issues. Methods and techniques of data analysis complement these procedures. They analyse the regularity and correct interpretation according to the nature of the data and assumptions on the whole population from which the data are derived. For most researchers, they are usually faced with a number of problems. Problems that are related to what to research for, how to conduct the research, the procedures to be followed, and so on. It is therefore the aim of this paper to outline the problems being faced by most researchers, and then outline briefly what should be considered when starting to think of a research topic, what are some of the methods of data collection techniques, and finally what is expected before and during data analysis. Issues related to presentation of findings or report writing do not form part of the scope for this paper.

THE PROBLEMS FACING RESEARCHERS

In considering the problems facing researchers, there are fundamental issues that need to be put in place in terms of the techniques and methodology used for research. Moser (1958) in his *Survey methods in social investigation* stated that research data at nominal, ordinal and interval scale cannot be treated in the same way. In addition different techniques should be applied when considering one cause and one effect or various combinations of causes and effects; and finally, the techniques of statistical coverage is important. The question therefore is how well are researchers aware of these conditions before engaging research and the data to be collected? This section outlines some of the most common misunderstandings in the process of conducting a research work.

The problem of managing raw data.

The analysis of the relationship between population parameters and statistics on simple data is statistical analysis. Most

researchers are therefore faced with vital research decisions. A complete analysis of say for example in a housing problem therefore involves three levels of analysis: Analysis with the help of the housing area concepts; data analysis; and statistical analysis. What therefore are some of the major problems facing researcher? A few examples will be examined below.

Data analysis consist of discrete steps. The first problem is the reduction and ordering of the unordered raw data to a manageable data set. This is where data collected are organised, and re-organised, classified into recognisable categories. For example Hammond (1964) in his sociological work concluded that each variable, similar values are grouped together in classes and the distribution of values over different classes becomes visible. It is often easy to assess the time required for actual data collection, but when the researcher make a rough estimate of the time involved in conducting one interview, the number of interviewers or enumerators a week or month schedules can be drafted. Time required for preparation, processing, analysis and reporting is more difficult to assess and is usually greatly

underestimated. According to Ehrenberg (1975) there is a tendency to rely too much on sophisticated statistical techniques and too little awareness of their inherent limitations, or their suitability in particular circumstances, this could also be a source of problem for researchers.

The second problem is to do with the description of the data (Andrews 1974). In describing the data Andrews (1974) outlined two central characteristics which are important, and they are: What have the values measured in common; and To which degree do they differ from each other. These questions are two sides of the same coin. Both steps have to be repeated for each variable. In a guide for selecting statistical techniques for analysis social science data, Andrews (1974) displayed in **Fig. 1** a decision-tree for the correct use of descriptive statistics. Researchers are advised to understand the text first and to use this figure for later

reference. Under the previous problem, it was set to summarise a raw data set. Researchers alike are interested in two questions: (a) does any one measure give a good representation of the whole data set? In other words is there any single number by which we can replace our data set completely for instance a measure of central housing services. (b) If not, could we design a second measure which would indicate the most likely distribution around that measure of central housing services? The first question provides the ultimate data reduction to a single parameter or statistic (for respectively a population and sample of a population). Several measures have been designed to represent data with different characteristics. Taken as a group we can refer to them as a measure of central housing services, or central tendency (Andrews et al 1974).

The third problem has to do with tracing

relationships between variables at respectively interval, ordinal and nominal scales. Researchers are mainly faced with this problem because it has to do with the summaries of measures which were identified as the second difficulty step. The main purpose of using summary measure is to reduce the amount of data to one or more statistical expression which adequately describe the data set. In social sciences, housing and architecture, interest is likely to be focussed on establishing relationships between variables. The next step is to compare the behaviour of two data sets and investigate whether any association occurs. With help of correlation and regression and other association techniques the direction, magnitude and / or strength emphasized the importance of relationship in behaviour analysis (Moser 1958).

The fourth problem has to do with time series analysis (Box & Jenkins 1976),

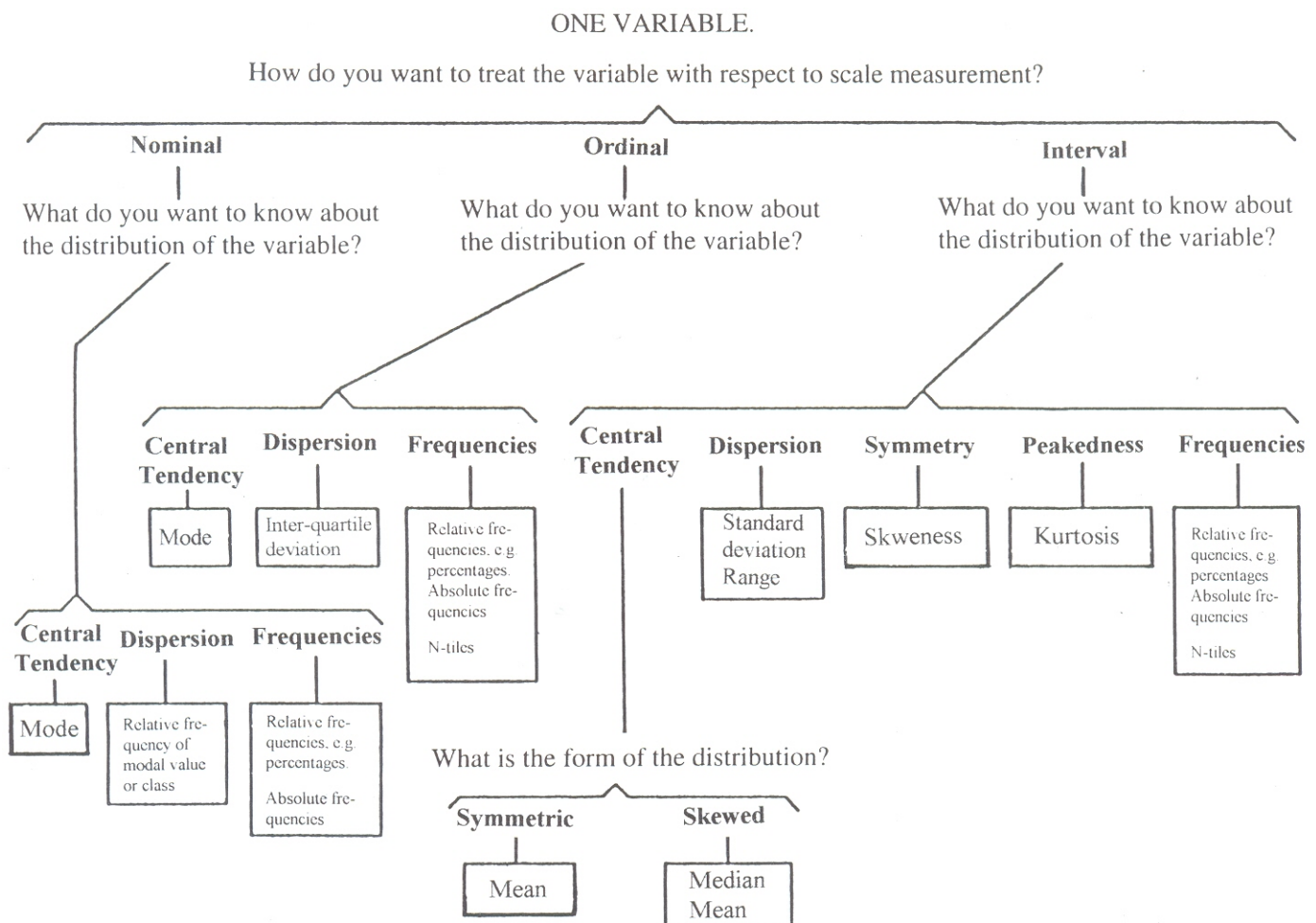


Figure 1. Decision-Tree for the Correct Use of Descriptive Statistics

where the analysis of measurements of variables over time is central concern. Researchers have always had the problem to distinguish between two types of data sets: a cross-sectional and time series. The former is to do with demographic, household budget surveys and so on, while the latter has to do with recording observation or measurements of variables that are a function of time which produces data sets which are called time series (Box & Jenkins 1976). This analysis concentrates on two types of questions: First, what is the structure that produces the pattern of a time series? secondly how can we forecast future behaviour or process by re-constituting the several components into a predictive function?

While the first question is of interest to researchers, the second one is particularly important to planners and architects. This requires on the one hand an assessment of the current situation (in a time perspective) and on the other hand anticipation of the effects of possible planned actions. By relating the analysis of these two factors to norms (objectives and goals) a need for planned intervention with reality results. Time series analysis is a good example of the need for complementarity between architects, planners and researchers. This requires the planners and architects to return feedback to researchers and ask of the researchers to have an open mind to the needs of the clients or society in general and their restrictive planning environment.

The Preliminaries of Research Design

The research design is the next most obvious problem, are the question of how to start designing research and examining resource materials is of vital consideration. This I believe is an important issue hence I will elaborate here. The initial reading and research design has always been a major problem for most researchers but more especially from developing countries where data availability is a problem and not usually reliable. Let us assume that the area of research and the problems which are to be examined have been decided in broad terms either from the home countries or just after registering for a course of study. Before the research can begin there must be a research design or proposal, spelling

out the process of the research in a clear and precise manner and outlining all the questions to be asked and the ways of measuring them. It is also assumed that the researcher knows a good deal about his subject matter before deciding on the study and the broad questions or issues for the research. It is also essential that having decided on these, the first step must still be to find out as much as possible of what other people have said about the subject. Keppel (1973) emphasised the fact the reading a research report with a view to further investigation has a surprisingly different perspective from reading for general interest. One obvious concern for most researchers is not only with what has been done, but what questions need to be formulated and why and how the answers were arrived at.

The first thing to do therefore is to gain access to a good library and learn how to use it well. Having read all the relevant books and articles on and around the subject and re-defined the research topic in the light of this new knowledge, more detail can be put into the research proposal. The question of methods of obtaining research information, of testing concepts or hypotheses and so on. There are a number of methods for the collection of primary data which are open to the student researcher. He may ask questions, he may observe behaviour, he may make experiments. Generally speaking a researcher may wish to question, or observe behaviour in its natural setting. Expect in small group studies the opportunities for experiments in society are limited. It is for example, too expensive to build a new town or residential neighbourhood in a particular way just to see the social consequences of so doing. The best one can do is to find a town or residential neighbourhood which was built in that particular way and examine the social consequences it had.

Another difficulty usually facing researchers is that there are generally so many factors involved in a social situation, in addition to those that one is interested in, that it is hard to disentangle them. If certain kinds of social behaviour are observed in our new town or residential neighbourhood how are we to know that they were the consequences of building the town in that way? Might it not have been the time that it was built or some

other exterior factor? One way around problems of this kind is to observe several new town residential neighbourhoods. If the social behaviour in question is found in all of them perhaps we can say that this behaviour, a high birth rate say, is associated with new towns. If X represents the new town or residential neighbourhoods and Y the high birth rate and X always goes with Y in every case we take, we can say that there is probably a connection between them.

This is not say that there is a causal connection as Keppel (1973) rightly states in "Design and Analysis: a Researcher's Hand book". But there may well be an intervening variable, in this case it might be migration, or more particularly age at migration, which has made the connection between new town or residential neighbourhood and a high birth rate. Suppose it is young married couples who most commonly move to new towns or residential neighbourhood, the birth rate is likely to be higher simply because young married couples are more likely to have children than any other section of the population. Sometimes it is easy, as in this hypothetical case, to spot what makes the connection between X and Y. Sometimes it is less obvious. One useful question then to ask is "X goes with Y, but can we find situations in which Y goes with non-X?". In this case, new town or residential neighbourhood birth rates, we might not find it for a whole town, but could find it for housing estates or residential neighbourhoods in old towns. Here again we might had a high proportion of young married couples and high birth rate and this would incline us to the view that it was the young couples who were the factors leading to the high birth rate in the new towns. The above illustrates a typical problem among research students.

Thus, supposing we were concerned with the population structure of new towns, how do we design the research proposal. If we just wanted the facts of the population structures of a new town, these can be simply measured, either from statistics already collected or by asking a sample of the population. This tells us nothing about social behaviour. According to Festinger (1954) as soon as we start asking questions about attitudes or behaviour our research design must be modified from a straight head counting

exercise. To understanding whether a new town or residential neighbourhood population is different ways from an old town population ways requires a comparison between the two.

To find out whether young couples in new towns behave differently from young couples elsewhere would require further comparisons. Young couples who go to new towns may be different not only from the rest of the population (as they obviously are by the definition of their age) but also in other ways. Thus one might want to compare them with young couples on new housing estates in old towns and with young couples in older areas of old towns. If young couples in all the new towns had characteristics in common which the young couples elsewhere did not share, then it might be reasonable to infer that there was some association between this behaviour (a high birth rate say) and the new living town couples. It would, however, not be reasonable to conclude that it was living in a new town which made them behave in this way. It might well be that these young couples behave like this (have more babies) for the same reason that led to the new town in the first place.

In order to clarify the relation between cause and effect a research design would have to include a number of questions about the motives for moving, attitudes about the ideal family size, and birth-control practices. Thus it is most important to work out quite clearly what are the research questions one wants answered and to design the research accordingly. It is equally important to realise what are limits of the statement that it will be possible to make as a result of research designed in the way proposed.

The population which is to be the subject of the research must be decided and other populations for control or comparison selected, if the researcher wants to be able to make statements about relationships which could not be based upon one population alone. Thus the statement "In this new town the birth rate is high" is meaningless by itself. The statement "In this new town birth rate is high compared with the national birth-rate figures. Generalisations about the birth-rate "in new towns" could not be made on the basis of the study of one town only. Generalisation about the birth rate of young couples in new towns cannot be

shown to have a connection with the fact of living in a new town unless the behaviour of other young couples as controls or for comparisons has also been looked at. According to the subject of the research and the questions, it is proposed to answer so the method of collecting the primary data. For some purposes it may be better to ask direct questions, for others to observe behaviour and for other again to use a combination of both methods. The researcher will better be able to judge what would be suitable for his research after considering the next sections some methods of data collection.

METHODS OF DATA COLLECTION

Data collection methodology deals with the correct preparation, organisation and implementation of data collection. A variety of data collection techniques are available. Each technique is suitable for particular data requirements only. Researchers in housing studies are usually faced with a number of data collection problems and techniques. Matching data requirements and data collection techniques is an important prerequisite for understanding housing studies especially in parts of the world where data available might not be very reliable. Each technique also has its own cost function, ranging for inexpensive field visits to expensive surveys. Matching means (time and money) with cost of data

collection is a second part of data collection methodology. Quality considerations also affect the choice of data collection techniques(s). Validity and reliability are two important criteria for quality control (Festinger et al 1954).

In selecting the methods and techniques for inclusion, preference has been given to relatively simple techniques which do not require special skills and large amounts of data. Hyman et al (1955) emphasized that many of the methods and techniques are concerned with enabling the researcher to improve his understanding of socio-economic and environmental processes and to structure and evaluate the development options that always exist in the preparation of plans. For the purpose of this paper the following 29 methods and techniques have been divided under two main headings: (Table 1) Methods and Techniques of Regional Analysis; and Decision-making and Planning Methods and Techniques are not only related to the physical but to the human component within the scope of environmental research.

According to Galting (1967) the purpose for which the methods and techniques of data collection can be used is summarised in Table 2. The table is intended as a user's guide and indicates whether the technique is primarily intended for purposes of regional analysis or regional planning and housing or both. In addition it shows the relationship of each technique with the five main questions

i. The methods and Techniques of Regional Analysis:	
Planning regions and programme areas.	Settlement topology Analysis
The geographical data matrix	Functionality analysis
The measurement of area and distance.	Rank-size analysis
<i>Population and population density projection.</i>	Network analysis
Gravity analysis of population projection.	<i>Settlement pattern analysis</i>
Spatial interaction of analysis.	Natural replacement measurement
Environmental impact assessment.	The location quotient.
Homogeneity analysis.	Ecological complex analysis.
Population density measurement.	Lorzen curve.
The coefficient of localization.	
ii. Decision-making and Planning Methods and Techniques:	
AIDA option graph.	Sieve analysis.
Threshold analysis.	Delphi method.
Goal achievement matrix.	Planning balance sheet.
<i>Compatibility / conflict matrix.</i>	Scenario writing
Planning, programming and budgeting system.	Decision trees.

Table 1 *Methods and Techniques of Regional Analysis and Decision Making*
Source: Galting, J. *Theory and Methods of Social Research*. Allen & Uwin. 1967.

	PURPOSE		The Five Ws of Regional Development Planning				
	R.A 1	R.P 2	What 3	Which 4	Where 5	When 6	Whom 7
Geographical Data Matrix.	x		x		x		x
Ecological Complex Analysis	x		x	x	x	x	x
Homogeneity Analysis	x	x	x		x		x
Functionality Analysis	x		x	x	x		x
Settlement Topology Analysis	x	x	x	x	x		x
Rank-Size Analysis	x		x		x		x
Settlement Pattern Analysis	x		x		x		x
Network Analysis	x		x		x		x
Measurement of Area and Distance	x		x		x		x
Spatial Interaction Analysis	x		x		x		
Natural Replacement Measurement	x		x		x		
Population Density Measurement	x		x		x	x	
Population & Population Density Projection			x		x		
Population Gravity Analysis				x		x	
Lorenz Curve	x		x		x		x
Location Quotient	x	x	x	x	x	x	x
Localization Coefficient	x	x	x	x	x		x
Environmental Impact Analysis	x	x	x	x	x		x
Sieve Analysis	x	x	x		x	x	
Threshold Analysis	x	x	x		x		
Compatibility / Conflict Matrix	x	x	x	x	x	x	x
Planning Balance Sheet		x	x	x	x	x	x
Goal Achievement Matrix		x	x	x	x	x	x
Delphi Method		x	x		x	x	x
Scenario Writing		x	x	x	x	x	x
The AIDA Option Graph		x	x	x	x	x	x
Decision Tree		x	x	x	x	x	x
Planning, Programming and Budgeting System		x	x	x	x	x	x

R.A = Regional Analysis. R.P = Regional Planning.

Table 2. *Methods and Techniques of Regional Analysis and Planning: User's Guide*
(Source: Galting, J. *Theory and methods of Social Research*, Allen & Unwin, 1967.)

addressed by planning - what, which, where, when and whom (the 5 Ws). It will be seen that while some methods and techniques addresses a limited number of questions, there are others with more comprehensive coverage (Gibbs 1961). Space will not allow me to discuss all the methods and techniques however, the following three methods will be considered briefly. The reasons is to cover at least most aspects of the research environment. The first considers the overall environment provided the stage in which all researches take place, hence settlement pattern analysis. The second example considers the population this is the human factor in the most research work, hence the population and population density projection. And thirdly the relationship which exists between and among the various components this usually requires some element of decision making hence compatibility / conflict matrix is considered in this section. For further discussion on the techniques see

Hyman et al (1955).

1. Settlement Pattern Analysis.

Settlement pattern analysis concerns the spatial distribution of settlements. In the study of settlements over wide areas, traces become difficult to use, and it is often impossible to analyse the scatter of settlements by inspection alone. It becomes imperative to devise some means of quantitative analysis of settlement pattern and researchers interested in settlement studies have long concerned themselves with the problem of evolving formulae for this purpose. In considering dispersion and concentration of settlements a number of variables have to be considered. In his analysis of human settlement, (Cox 1972) outlines a number of features to be considered these include; the number of settlements; the number of houses in each settlement; the size of the population in each settlement; the area of

the region served by each settlement; and distance between settlements.

No one formula has been satisfactorily devised which would take all these variables into consideration, but a number of indices, in which two or three variables are involved, may be used to map certain distributional aspects. A selection of these indices that seems to hold promise for areas where data are at best deficient, may be briefly considered. Since information about number of inhabitants and houses is often yielded by census returns, the average size of settlements as determined by inhabitants or houses may be obtained from the formula (Cox 1972):

Number of inhabitants or houses in selected area

Number of settlements in selected area

Obviously, this index say little about dispersion or concentration. The result may even be misleading. Some idea of settlement dispersion may be deduced from the formula:

$$I = \frac{S}{H}$$

where I = Index of dispersion;
 S = Number of settlements in any selected area;
 H = Number of isolated houses (any house that is situated a quarter of mile from any other house).

McKinnel (1965) have argued that concentration of settlements is a function of the number of houses in each settlement (H/S) and of the number of settlements in a given area (A/S). Considering both functions, the index of concentration is obtained:

$$C = \left(\frac{H}{S}\right) \times \left(\frac{A}{S}\right) = \frac{HA}{S^2}$$

Although Berry & Garrison (1953) in their central place hierarchy have shown that settlement concentration can also be derived from settlement traces that have been gridded with a network of 25km. squares. Two formulae present themselves:

$$1. \text{ Mean value of concentration: } \frac{As}{S}$$

where: As = The area occupied by the settlement in square km; and
 S = The number of settlements.

$$2. \text{ Coefficient of concentration: } \frac{A}{As}$$

where: A = The area of the square (25sq km); and
 As = Area occupied by settlements (including gardens).

All these measures have the serious shortcomings that the crucial aspect of the patterns of settlement, for instance the distance between settlements, is not touched upon. The best measure of dispersions, or for that matter between all sorts of elements (farmhouses) is their distance apart from one another.

2. Population and Population Density Projection

Isard (1960) in his regional analysis, expressed the fact that as with gross and not reproduction rates, population growth and density rates can obviously be used for projections into the future as well. In its crudest form the forecast population is

obtained by using the following formula:

$$P_{t+1} = P_t \times r$$

where: P_{t+1} = Population at time point t ;
 P_t = Population at time point $t+1$;
 r = Natural growth rate (crude birth rate minus crude death rate).

But on the other hand Cox (1972) emphasises that the natural growth rate can be based on actual or expected birth and death rates. Refinement can take place by using for example age, sex, and or ethnicity specific birth and death rates. If applied to density, a crude projection of population densities can be derived from the formula:

$$PD_{t+1} = PD_t \times r$$

where PD_{t+1} = Population density at time point t ;
 PD_t = Population density at time point $t+1$;
 r = Natural growth rate.

To make a crude projection of population size and/or density for a next generation, net reproduction rate could replace r in both formulae. Population can only be effectively measured if a whole generation is to put the following test. For details, see 'The population census reviews and research' by Benjamin (1970). Are fertility and mortality in a population such that a generation, permanently subject to them, could during its own lifetime produce enough children to replace itself. Preferably, such a test should be devised to consider only female births. If a generation of mothers is successful in producing exactly replacing the same number of mothers in the second generation, then it could be said to be exactly replacing itself. Two rates present themselves: the gross reproduction rate and the net reproduction rate. These methods are only concerned with biological determinants of population growth; migration is ignored (Warntz 1964). Unless migration figures and forecasts are included, the value of these measures for planning purposes remains restricted.

Since the index of change (IC) also reflects the migration experience of any given population, substituting the natural growth rate and the reproduction rate for the index of change may yield better

results. If vital statistics are rather complete, Young (1947) suggested that it is relatively easy to compute a number of indices indicating population change as occasioned by both natural increase and migration. But such statistics are often lacking in developing countries and the best source at hand is then again the census (Lawan 1991). If the census schedule makes distinction between place of birth and place of residence, as is often the case, it can also be assessed. The unspecified intercensal population change would be determined by: Population at time point $t+1$ population at time t . This produces the so-called index of change (Young 1947).

3. Compatibility / Conflict Matrix.

According to Duverger (1964) the compatibility / conflict matrices are extensively used in decision making theory and are beginning to be systematically applied to decision making problems in Housing as well as planning. The subject of the matrix might be sets of goals, objectives, strategies, action programmes and so on. In its usual form the matrix is a simple graphical display of technique and is used to show where some compromise is necessary and where the elements in the matrix reinforce each other. Incompatible elements can be modified or removed from the proposals, and compatible elements strengthened. The effectiveness of the matrix can be improved when each other element is given a weighting factor based upon its respective desirability or importance.

This graphical device has found much application in housing, land use planning (Duverger 1964, Madge 1965). After listing all potentials housing condition, or land use, each category is subsequently tested against all others to determine either compatibility or possible conflict. Once completed, the matrix would demonstrate optimum housing area or land use as well as opportunities for multiple use for land use (Duverger 1964). For example, an area that has been shown to have a high potential for forestry would also be compatible with extensive livestock keeping, wildlife management, recreation and water management and so on. In addition to a matrix whereby row

and columns are at right angles, another type of matrix be employed in all such instances where a limited number of options have to be examined as indicated in the Fig. 2. For further details see Chadwick in his book 'A systems View of Planning 1971.

THE STRUCTURE OF DATA ANALYSIS

Data analysis according to Howard and Sharp (1983) is defined as information gathering by observation, through books or pictures, field survey laboratory experiment and so on. But the data analysis and types of research used have to be classified according to their purpose into exploratory, descriptive, explanatory and testing type of activities (Christensen 1977). In this section I intend to review briefly the techniques of data analysis as required in different types of research undertaken.

Exploratory research: As yet, little knowledge is available on the identified problem in this stage. A planner or / and architect will ideally collect available statistics, maps report etc to provide him with initial assessment on how much is already known. He may also decide after this initial preparation to pay a visit to (a) particular area(s) or other institutions to make observation and consult resource persons. The technique of data analysis are limited therefore to a few summary measures, map interpretation, classification and so on. Recording of observation and interviews is important.

Descriptive research: An initial inventory of the problem has now taken place and the purpose of the investigation is to establish precise measurements of magnitude or distribution of phenomena. Data analysis techniques most commonly used include measures of central tendency, measures of dispersion, frequency distribution and spatial analysis for example map interpretation.

Explanatory research: As explanatory investigation aims to establish techniques are require between variables, more complex data analysis be related to one another at this stage. At least two variables have to be related to one another, and their strength, magnitude and direction established. An assessment of sampling and observational errors in

cross-sectional studies and of incidentals errors in the time series studies will be required. Techniques most commonly used are cross-tabulation, and correlation and regression analysis. These techniques also assume that descriptive statistics have been calculated.

Testing type of research: In this stage basic causal relationships between independent and dependent variables have already been formalised in a model. The investigation's basic aim is to test components of overall predictive value of the model, for instance calibrating the model. Typical questions are suitability of transformations of variables into log or other values for an improved version of model, or the investigation of the basic assumption of model and techniques applied. This stage of research is more common in macro-economic planning and architecture. Ideally all the first three types of research methodology are present in architecture and planning oriented research. The point to emphasize here is that the research oriented design offers alternatives for action as well as a rationale for decision making. Not only does the skills of analysis provide such

understanding but also a good choice of research design strategy and an intimate relationship between the research and subject matter. The usefulness of the analytical tools here have always been a problem to students on how to go about designing research proposals as well as to understanding the process and problems of a research issue.

CONCLUSION

In conclusion, it is the aim of this paper is to have outlined some of the problems facing most researchers not only in the human environmental sciences but also in the physical sciences. Effort has been made to highlight some of the pre-conditions necessary before designing a research proposal, data collection methods and data analysis. In addition a wider view as to the number of techniques that could be utilised in the process of data collection, analysis and synthesis were also examined. Although there is also a need to examine some of the presentation techniques, this is beyond of the scope of this paper.

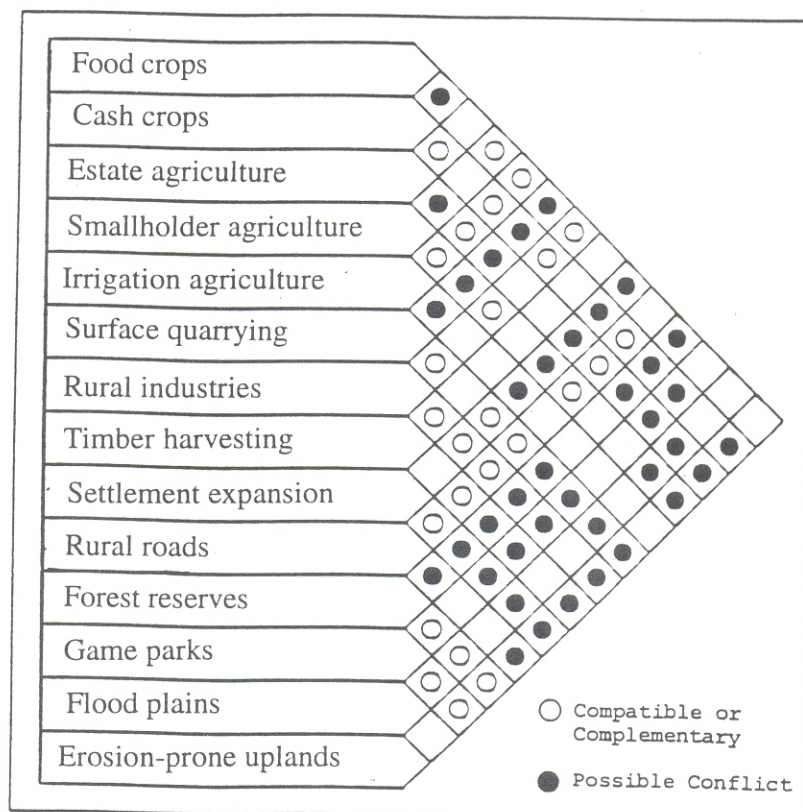


Figure 2. An Example of a Compatibility/Conflict Matrix
(Source: Durerger, M. *Introduction to the Social Science*, Allen & Unwin, 1964.)

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