THE NATURE OF SPATIAL DATA

Adapted from Liebenberg and Vlok 2000, The interpretation of Maps, Aerial photographs and Satellite images.

Spatiality

All geographical data have a spatial component. We could state this differently by saying that data that do not have a spatial component are not considered spatial data. Because all geographical phenomena occur somewhere on the earth's surface, they all have an absolute and a relative location, as well as a spatial distribution. We know, furthermore, that all spatial distributions show spatial variation because geographical phenomena are not necessarily distributed evenly across the earth's surface. The interaction between two phenomena within the same area leads to spatial covariance and association, whereas the interaction between a large number of phenomena within the same area leads to spatial interaction and spatial processes. With the exception of spatial interaction and spatial processes, all these spatial aspects of data can be directly represented on maps and therefore also read off maps.

Temporality

All geographical or spatial data have a temporal aspect in the sense that the location and distribution of geographical phenomena also vary over time. In practice this permits two possible investigative methods. These two possibilities are illustrated in tables 1.1 and 1.2. One possibility is that each observation could indicate a different place. In table 1.1, for example, you will find an entry or observation for each of the five countries in respect of each of the four variables. However, each entry relates to the same time, namely 1999. If we were to represent these data on a map, either we would have to use a map of the world on which all five countries appear, or we would have to draw a separate map for each country.

Table 1.1: Data set for one geographical phenomenon, consisting of observations at five different places in respect of four variables for the same year (1999). Geographical phenomenon = Population

Variables

Observation	Total population in millions	Population density in numbers per km ^{2}	Population growth rate per 1 000	Mortality rate
	x_1	x_2	x_3	x_4
South Africa	42,6	90	1,6	11
Zambia	9,7	33	2,0	23
France	59,1	277	0,3	9
Japan	126,7	869	0,2	7
Canada	30,6	8	0,6	9

A second possibility is that each observation relates to another time and that all the observations together (that is, the variables) relate to the same place. In table 1.2 all the observations relate to South Africa and they indicate how the respective variables changed during the period 1950 to 1999. To map these data, we would have to use six maps of South Africa --- one for each year.

Table 1.2: Data set for one geographical phenomenon, consisting of six observations at the same place (South Africa) in respect of four variables for six separate years (1950--1999)

Variables

Observation	Total population in millions x_1	Population density in numbers per km^2 x_2	Population growth rate x_3	Mortality rate per 1 000 x_4
1950	15,21	11	1,73	24
1960	18,28	14	2,12	20
1970	22,76	19	2,27	17
1980	28,62	24	2,36	14
1990	33,75	28	2,48	13
1999	42,60	90	1,60	11

Scale or level of resolution

The scale-relatedness of geographical data is of cardinal importance. You will remember that we referred to this briefly when we explained exactly what a map is, namely a reduced and simplified representation of the spherical earth on a flat surface. The question is: to what extent is the earth's surface or a portion of it reduced?

The answer of course is that there are an endless number of possible methods of reduction, because it depends on how large the portion of the earth's surface is that we want to represent, and how large the map is that we want to draw. In practice, however, it is easier to think of the size of the area we would like to represent. In this regard it is useful to remember that whereas astronomers study the entire knowable universe, and nuclear physicists minute, invisible particles such as atoms, protons and electrons, geographers confine themselves to the study of the earth. In practice, however, it makes a big difference whether we are studying a phenomenon such as population density on a global scale (or macro scale) as it is also sometimes referred to, or whether we are investigating population density in our town or the city block in which we live (ie on a micro scale). If for argument's sake we were to study the phenomenon of population density in Southern Africa, we would be investigating the phenomenon on a meso scale. The prepositions macro, meso and micro are derived from the Greek and mean, respectively, "large","medium" and "small".

It is logical to assume that an investigation conducted on a global scale would be less detailed and more generalised than an investigation on a micro scale. In geography we call the degree of detail the resolution level of the study. A micro scale investigation has a high level of resolution and a macro scale investigation a low level of resolution. In figure 1.2, for example, you will notice that if we were to refer to Unisa's main building in a study of world architecture (ie macro scale), we would write no more than a few lines on it. If we were to describe it on a meso scale in the context of Southern African universities, our discussion might take up a whole page. In contrast, a micro level study of Unisa's main building would contain so much detailed information that it could well fill an entire book.

Dimensionality

If you have already completed the first-year geography, you will know that all spatial phenomena shown on a map appear as dots, lines and areas. If you did not, take a look at any map and you will soon see that this is so. An isolated phenomenon like a town, house, tree or church is symbolised by a dot, for example. A line is used as a symbol for linear phenomena such as roads, railway lines and rivers, and an enclosed space (also known as a polygon) is representative of a phenomenon which has area, such as a soccer field, an orchard, a street block, a farm, district or field. In cartographic language we say that:

- Dots are zero-dimensional because they have no distance dimension.
- Lines are one-dimensional because they have one distance dimension.
- Areas are two-dimensional because they have two distance dimensions (length and breadth).

The statement that all phenomena are represented by dots, lines and areas has a catch in it which confuses many people. Let us see whether you will immediately realise what the problem with this statement is.

It is of course related to the fact that a phenomenon like height above sea-level is also represented by line symbols (contour lines), although in reality it is not a linear phenomenon. It is also related to the fact that cities like Pietermaritzburg, which is an area phenomenon, is merely a dot on many maps (road maps and tourist maps). What is the solution? The answer lies in the following:

- Even if all phenomena are represented by dots, lines and areas, there are certain phenomena which are three-dimensional, such as height above sea-level, which is also represented by line symbols (in this case contour lines).
- Even if it is correct to state that all single phenomena (houses, windmills, schools) are always represented by dots, and linear phenomena (roads, rivers and canals) are always represented by lines, in reality this depends on the scale of the map. For example, a place like Nelspruit is just a dot on a world map, but on the 1:50 000 map 2530BD NELSPRUIT in appendix D the built-up area of Nelspruit is an area represented by an area symbol (light grey). Similarly, the Amazon River in South America is represented by a line on a map of the world but as an area on a map of the Amazon Basin.

We will return to these "problems" when we take a look at the various map elements required to represent the earth's surface on a piece of paper. At this stage it is important to remember that whereas the cartographer works with map symbols with zero, one and two dimensions, he or she often has the task of representing geographical data which have three dimensions. Three-dimensional data are known as volume data and figure 1 illustrates how such data can be represented by dots, lines or areas, depending on the function of the map.

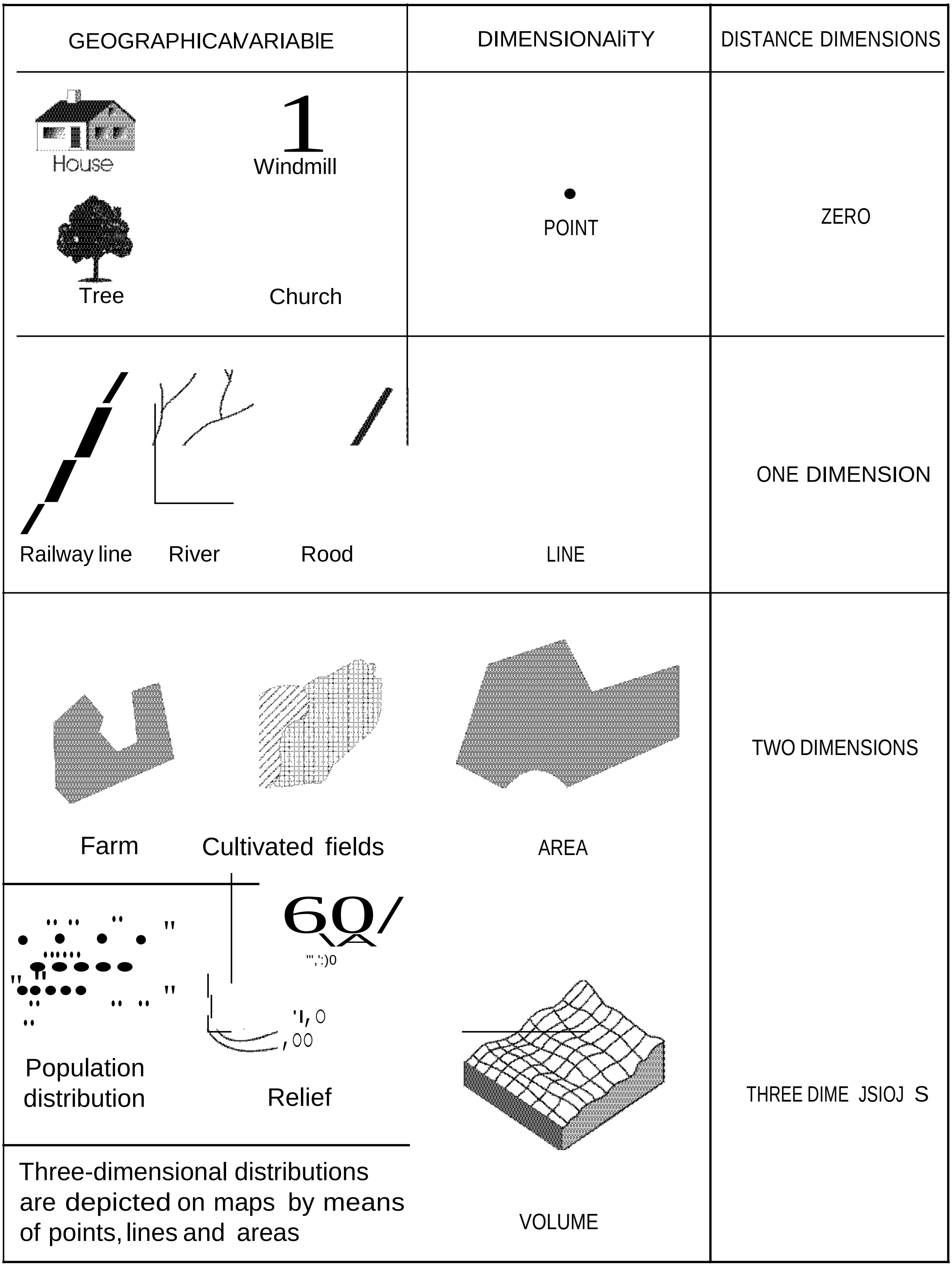

Figure 1: The dimensionality of geographical data