MAPPING AND ATLAS PRODUCTION

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Contents

Summary

Visualization, which is essential in geographical data, is the analysis of its characteristics, as well as the analysis of the visualization or communication objectives. On the basis of these objectives, appropriate map types are selected for representation of the data, allowing map users to gain appropriate views of the geographical reality selected for them.

Because maps are selections, restricted to specific areas, themes, and timeframes, the selection, coupled with generalization, enables them to provide spatial insight and be spatial decision supports.

1. Introduction

By visualizing the geographical distribution of phenomena, an extra dimension suitable for management purposes, for analysis, and for decision support is provided. For this visualization a number of methods (*map types*) have been developed in each of which the phenomenon is rendered with specific symbology.

These symbols are rendered on a *base map*. As soon as measurements of Earth are known, and the location of individual points on Earth are known, it is possible to portray larger or smaller parts of spherical Earth (geoid) on a flat plane, as on a map sheet, according to some systematic method (projection), preferably one that enhances the possibilities for map interpretation **(see *Geodesy and Topography*)**.

Attribute data on geographical objects or spatial phenomena are collected through fieldwork, aerial photography, *remote sensing*, or censuses and questionnaires **(see *Remote Sensing*)**. Processing and visualizing these attribute data aims at making them accessible for map use and interpretation.

Map use is a logical part of cartography, the discipline that adjusts spatial information to specific uses in order to solve spatial queries and problems, stressing visualization and interaction.

The production of maps is a digital process nowadays, as can be the case for map use. In its present form, map use has been extended into spatial data use, and takes place in digital geographical information systems **(see *Geographical Information Systems*)**. It is in this electronic environment that digital techniques for measurement, analysis, and presentation are made available.

It is the juxtaposition of maps with different topics (*thematic maps*, such as soil maps, vegetation maps, precipitation maps, etc.) for the same area that allows extra interpretation possibilities, as relationships between these phenomena will be suggested when they are compared.

This juxtaposition of thematic maps comes out best in the format of *atlases*, that is, combinations of maps that have been structured in such a way as to convey a specific message. It is a way of condensing spatial information sets into manageable proportions.

2. Maps and Map Types

Maps are two-dimensional models of three-dimensional geographical reality in which, through the use of corresponding symbols, one portrays the relative positions of geographical objects.

This modeling ranges from near-realistic panoramic landscape maps to abstract statistical or geophysical maps rendering ratios or combinations of parameters, as on climatological maps.

Generally, the following information would be expected to be available on a map, be it a paper one or one displayed on a computer screen: the map proper (a graphical representation of reality displayed at a specific scale) combined with a *title* (indicating map theme and map area), a *subtitle* rendering specifics of the theme or the mapping procedure and mapping data, a *legend* explaining the use of symbols and signatures on the map, an indication of the *map scale* in either numerical or graphical (scale bar) form, an indication of the *author, date of production*, and *sources*.

Incorporation of *metadata* on the quality of the map data would enhance map use possibilities, as well as, for accessing similar information, the *imprint* (name of the publisher with place and date of publication).

If the orientation of the map is different from north, a *north arrow* should be displayed as well. In a digital environment all these aspects additional to the map proper need not necessarily clutter the display screen, but at least they should be accessible immediately when necessary (as through pop-up menus, for instance).

According to the nature of the phenomena or the kind of map use envisaged, there are various options for modeling geographical phenomena, resulting in different map types. The aspects taken into account here are:

- The measurement scale of the attribute data of the geographical objects
- The geographical nature and scale of the geographical objects
- Whether the phenomena studied are defined as continuous, discrete, or discontinuous

Regarding the *measurement scale*, attribute data of geographical objects can be nominal (expressing different qualities); they can be ordinal (a hierarchical sequence without specific values for the measurements); they can be on an interval scale (in which case the measurements can be measured with specific numerical values, but the point of reference or datum is a subjective one, preventing the expression of ratios between the measurements); and they can be on a ratio scale, in which case the measurements have both numerical values and can be compared to each other by expressing ratios.

Examples of geographical data measured on a nominal scale are soil types, or vegetation classes. Examples of ordinal data are classifications of human settlements into hamlets, villages, towns, and cities.

Hypsometric or temperature data are examples of data measured on an interval scale: both the national height datum and the degree Celsius (ºC) reference temperature are subjective values: one can neither say that a 300 m hill is twice as high as a 150 m hill, nor that a 20ºC (68°F) average is twice as high as a 10ºC (50°F) average. Examples of data measured on a ratio scale would be income or production figures, or precipitation data.

The *nature and scale of the geographical objects* would refer to whether these would refer to point, line, area, or volume objects. Scale is important here, as areal phenomena such as cities might be considered as points when the scale of representation becomes too small.

Geographical phenomena can be continuous, that is, present all over Earth like precipitation or temperature, continuously varying in value; they can be discrete (occurring only at specific areas) like specific types of land use; and they can be discontinuous (having discrete values like population density values for adjacent areas).

On the basis of these measurement scales of the attribute data and the nature of the geographical objects or phenomena, we can group the various map types as in Figure 1.

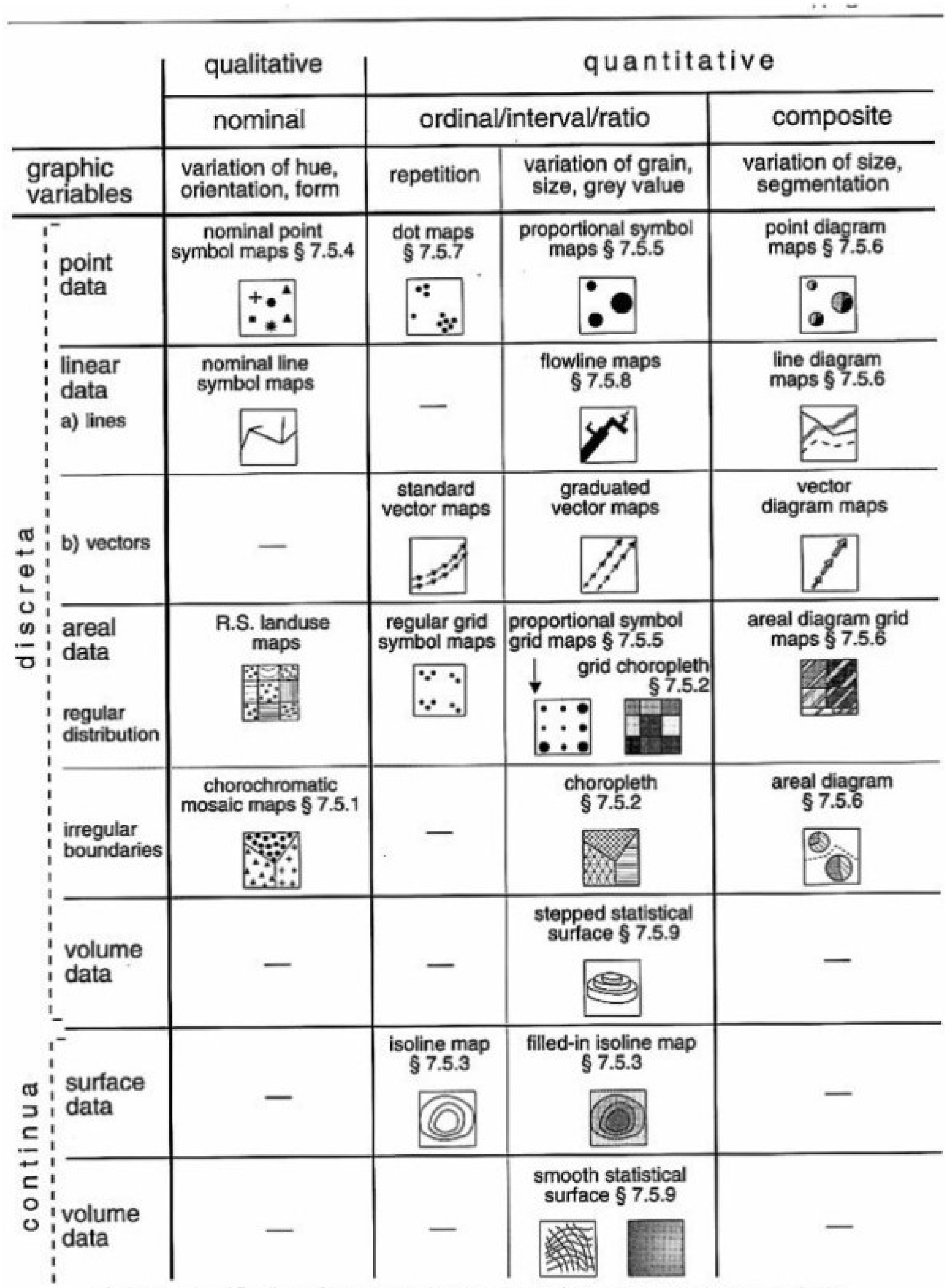

Figure 1. Classification of map types
(Source: U. Freitag, Cartographic Conceptions: Contributions to Theoretical and Practical Cartography 1961–1991 (Berlin: Freie Universität Berlin, 1992))

Point data can be rendered as follows (examples of the various map methods discussed in this section are given in Figures 2a–2j):

- Nominal point data are rendered in a *nominal point symbol map.*
- *Dot maps* render quantities through repetition of dot symbols (Figure 2b).
- *Proportional symbol maps* render quantities through dot symbols that are proportional to the values to be rendered (Figure 2f).
- *Point diagram maps* show both quantitative and nominal information.

Linear data can be portrayed through lines or vectors, using:

- *Nominal line symbol maps* (different line forms denote different linear characteristics, such as streams, boundaries, roads).
- *Flow line maps* have lines that indicate routes followed and widths that are proportional to traffic density or traffic load.
- *Line diagram maps* have both quantitative and nominal information.
- *Vector maps* show the location of forces and the direction these are working in; a specific force can be rendered by either a number of standard vector symbols or a proportional vector symbol (Figures 2h, 2i).
- *Vector diagram maps* show the strength of the forces, their direction, and their differences in some nominal aspect.

Areal data can be rendered for regular grid cells and for irregular areas (statistical areas, municipalities, soil units). In the case of regular grids we discern:

- *Satellite imagery land cover maps* (numerical radiation values are converted here into nominal information like vegetation classes)
- *Regular grid symbol maps* (values for grid cells are expressed through combinations of quantitative symbols)
- *Proportional symbol grid maps* (values for grid cells are rendered through proportional point symbols; Figure 2e)
- *Grid choropleth maps* (values for grid cells are rendered through variation in color value; Figure 2g)

Apart from *choropleth maps* (Figure 2d), data for irregular areas can be expressed through:

- *Chorochromatic or mosaic maps* (nominal data are expressed by difference in color or pattern; Figure 2a)
- *Areal diagram maps* (values for areas are expressed by diagrams; Figures 2h, 2j)
- Volume data are rendered through the *stepped statistical surface* method, where discrete values are expressed by the height above the map plane
- Continuous areal data are expressed by the *isoline map* method, which can be visually improved when the zones between the isolines are filled in with increasingly dark shades, suggesting sequences of values (Figure 2c)
- Continuous volume data can be rendered in *smooth statistical surfaces*. Of course, combinations of these individual map types can be produced as well.

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Biographical Sketch

Ferjan Ormeling was born in Utrecht, the Netherlands, in 1942. He took his B.Sc. in human geography at Groningen University in 1966, and his M.Sc. in human geography and cartography in 1969; he worked for Wolters-Noordhoff Atlas Productions, Groningen, 1961–1968, and for Utrecht University from 1969 to the present. Dr. Ormeling received his Ph.D. in the social sciences in 1983 at Utrecht University (his thesis topic was *Minority Names on Maps: The Rendering of Minority Place Names on Topographic Maps of Western Europe*) and has been head of the Cartography Department, Faculty of Geographical Science, Utrecht University, since 1981, holding the chair of cartography since 1985.

Dr. Ormeling was engaged in the IGU/ICA Joint Working Group on Environmental Atlases (1976–1984), and has been on the ICA Commission on National and Regional Atlases since 1985 and the ICA Commission on Education and Training (CET) since 1972; he was chair of CET from 1987 to 1999 and was appointed secretary-general of ICA from 1999 to 2007. He has (co)organized seminars on cartographic education and training in Morocco, Thailand, China, Indonesia, Turkey, and Cuba.

Dr. Ormeling has been editor of Netherlands cartographic journal *Kartografisch Tijdschrift* since 1972 and is co-editor of the *National Atlas of the Netherlands*. He was president of the Netherlands Cartographic Society from 1995 to 1997 and was made an honorary member of the Netherlands Cartographic Society in 2000.

Dr. Ormeling has been a member for the Netherlands of the United Nations Group of Experts on Geographical Names since 1980 and convenor of the UNGEGN Working Group on Training Courses on Toponymy. He has participated in United Nations toponymy courses in Indonesia, the Netherlands, Tunisia, Mozambique and South Africa.

Dr. Ormeling's research interests are electronic atlases, toponymy, and the development of thematic cartography. He is the co-author of two cartographic textbook series—*Basic Cartography* (4 vols., together with R.W. Anson, 1987–2002) and *Cartography, Visualisation of Spatial Data* (with M.-J. Kraak, 1996, 2002) also published in Dutch, Polish, Russian and Indonesian.