Regional Recognition and Delimitation from Topographic Maps: User Strategies

This is a report from a pilot study conducted with nine geographers to delimit regions on a map they were not familiar with. The participants varied greatly in age and experience. Making notes as the users talked through their thinking provided insight into how such complex maps are read. Experienced geographers with larger geographical vocabularies sought to distinguish salient patterns. No simple relationship could be established between experience and region-dividing strategies. Suggestions are made for expanding such studies.

Christopher Board
Department of Geography
London School of Economics
and Political Science
London, UK

THE GEOGRAPHICAL CONTEXT

This paper will concentrate on "map use in its classic form, a percipient interacting visually and mentally ... with a single map" (Wood, 1993a, 112) and the process of reading, analysis and interpretation. It will also focus on level 3 (Olson, 1976) or higher order tasks (Board, 1984), summarized as the application of deep-structure information to decision-making and content-knowledge-building for problem solving.

Geographical education from the turn of the century seized the opportunity of studying landscapes on relatively large-scale topographic maps which were increasingly available (Herbertson, 1902; Geikie, 1901). By the 1920s and 1930s texts on map reading and interpretation were commonplace, compulsory map interpretation questions were typical of British public examinations in geography, encouraged no doubt by the flowering of the regional paradigm. This situation continued well into the 1960s, although the textbooks often separated physical and human landscapes. Candidates were expected to integrate these into regional recognition and division. As a student who was brought up to employ this form of map use, I was expected to undertake this geographical task using the evidence provided on the map and not information I might have acquired directly in the field or from reading.

In his formidable geographical study of Germany, Dickinson (1953, 416) "sought to recognize a limited number of clearly recognizable landscape types that could be consistently and legibly mapped over the whole of Germany on a scale of 1:200,000". These landscape types were essentially based on physical characteristics, but their recognition was in part related to human occupance. This approach to environmental understanding based on a topographic map series has probably not been surpassed. It represents a high-water mark in regional map analysis. Such map use became rarer after the Quantitative Revolution. Muehrcke has documented the decline of geographical map use and the rise of statistical geography alongside a more professionalized cartography with a heavy emphasis on thematic, statistical map design (Muehrcke, 1982).

"This approach to environmental understanding based on a topographic map series has probably not been surpassed. It represents a high-water mark in regional map analysis."

THE CARTOGRAPHIC CONTEXT

Research into the cognitive aspects of map use, related to changing paradigms in psychology, has developed apace in the last quarter century. Despite pioneering work such as that by DeLucia (1976) and many others reviewed by MacEachren (1995) and Wood (1993b) and the renewed interest in visualization, our understanding of how maps are read is still incomplete. However evidence is accumulating that levels of experience

". . .surprisingly, comparatively few accounts of research using complex general-purpose or topographic maps have been published. . ."

of map use and geographical study are associated with more successful map reading and map learning. But, surprisingly, comparatively few accounts of research using complex general-purpose or topographic maps have been published, although MacEachren cites Geoffrey Edwards (1991) who contends that the "ability to take the landscape analysis approach depends on being able to access labels for the features from memory. Experienced map readers are said to have 'a whole dictionary of names' for grouped entities which he or she carries around her head, allowing her to read and understand maps more quickly and effectively.' . . . For the experienced map reader, an extensive vocabulary exists that defines and labels complex entities." (MacEachren, 1995, 394). In parenthesis it should be acknowledged that the chunking process referred to by Edwards (1991) was described by Head in his 1984 work.

Michael Wood and his associates recognized that a deeper understanding of map interpretation needed a study of the knowledge structures and map reading strategies of users. They employed protocol analysis (Gilhooly et al., 1988; Kinnear and Wood, 1987) with both experienced and inexperienced map readers as did Thorndyke and Stasz (1980) but in contrast to the latter, their research used complex maps of the real world. Similarly Kulhavy and others (1992) have also used protocol analysis on a complex, general map in the *National Geographic Magazine*. Both of these studies emphasize memory and learning.

As far as I am aware there has been no modern study of experts' geographical interpretation of complex topographical maps in the mold of that once so popular in geographical education. Gilhooly et al. (1988) concentrate on contour patterns while Edwards (1991) deals principally with remotely sensed images. We must remember nevertheless that topographic maps select features and present them with varying degrees of emphasis according to national or regional styles and specifications. What applies to remotely sensed images may not apply to map reading.

In a pilot study some map interpretation protocols were informally recorded in a small seminar I organized in the mid 1980s. Four participants in turn described the patterns seen on maps of areas with which we were not familiar. Each chose a map for others to describe. Transcribing the rather rambling accounts after an interval of a decade reveals that they may not be an adequate guide to map reading strategies and that word counts of our murmurings may convey spurious precision. This is not to denigrate the research methodology of Kulhavy et al. (1992) but to argue for a looser, more anecdotal account which I believe can be captured by note taking during a session when the user is thinking out loud while map reading. Informed by this exercise I devised a new one in which geographers were asked to describe regional patterns on maps. Because the aim of my study was to discover what different strategies were adopted by map readers for one task, there was no need for a formal experimental design demanding quantitative data on accuracy or time of recall. It is recognized that further study and analysis of map-reading strategies will require a more formal design.

"This is . . . to argue for a looser, more anecdotal account which I believe can be captured by note taking during a session when the user is thinking out loud while map reading."

THE PRESENT STUDY

Building on the pilot study, the aim of this study was to examine the strategies by which skilled map readers approached the task of regional division on topographic maps. This higher-order task is what was expected of educated geographers.* Nine experienced map-using geographers were invited to divide the area on the map into regions of distinctive landscape type. The objective was to record the essence of the strategies adopted by each geographer to undertake this task. All had degrees in geography. Their ages ranged from 25 to 77. Four were female and four

had been trained recently. Different maps were presented to each individual, all but one on the scale of 1:50,000. All the maps chosen had fairly clear regional patterns. Most participants had seen examples of the map series, but none had studied the particular sheet in question. Nevertheless all but two of the geographers were familiar with the geography of the country whose maps they were reading: giving them a better chance of describing geographically significant patterns. To have asked individuals to delineate regions from graphic patterns, and also to deprive them of the benefit of readable place-names would have reduced the study to one of recognizing pattern without necessarily seeing what it meant. That would have been another study with a different aim.

Subjects were interviewed on their own but their comments were not recorded verbatim. Although detailed notes were kept of the thinking-aloud sessions, it must be acknowledged that these may be partial and selective. In one case a map reader offered a sketch map of the regions he had devised, but in other cases it has proved possible to reconstruct such a map. In retrospect, perhaps it would have been wiser to ask all respondents to reconstruct their regional division on a piece of tracing paper or film of exactly the same size, to avoid any suspicion that inability to create freehand copies might distort the conclusions. This delineation of regions should be done with the topographic map at hand, so that memorization can be eliminated as a factor. This act of interpreting regions to reveal unknowns tends to be at the intensive "private" interaction node between map user and map (MacEachren, 1995, Fig. P.III.1, p.358).**

"... all but two of the geographers were familiar with the geography of the country whose maps they were reading ..."

"This act of interpreting regions to reveal unknowns tends to be at the intensive "private" interaction node between map user and map."

RESULTS

1. All nine map readers scanned their maps several times making several trials of a regional division. Two of them missed some significant detail. One, a cartographic researcher and map librarian, strayed into cartographic technicalities and details of the specification rather than concentrating on the landscape. The one who was least experienced spent much more time looking at some detail, missing others.

2. All nine used terms from the geographical vocabularies they commanded. Some features were given names from type localities, e.g. fjord, fells, garden city. All used a rich list of adjectives to qualify features: two dimensional shape and three-dimensional morphological qualifiers being the most common. Some terms were very specific to landscape description, e.g. accidented relief, mature valley (a Davisian term), organized networks. Relatively complex concepts such as relief, enclosure, clearance, and settlement were typically employed. Others such as good walking country are personal, idiosyncratic or private, meaning much to the individual concerned. A varied selection of terms were employed to describe location, distribution and arrangement from the relatively simple clustered and evenly distributed to focused, radiating and interdigitated.

"Relatively complex concepts such as relief, enclosure, clearance, and settlement were typically employed."

3. All map readers linked small features such as those appearing in the legends of maps into larger chunks often relating land use to physical features. These include valley bush on the Kidd's Beach map, for the prevalence of a type of forest surviving along valleys in a repeating pattern over wide areas. Another more complex example was the recognition of areas around villages where the forest had been cut back, noticed on the Belgian map, although in this case there appears no English term for this. Another recognized what he thought was a drumlin field on the Bavarian map.

Map Readers	DR	PD	RJ	WD	TA	LC	WM	GK	LP
Traditionally or recently trained	T	R	R	R	T	T	T	R	T
Map number in list	8	3	7	1	4	6	5	9	2
Procedures adopted by map readers									
Wide Scan	+	+	+	+	+	+	+	+	+
Repetition	+	+	+	+	+	+	+	o	+
Have Geographical Vocabulary	Y	-	+	Y	+	+	Y	-	+
Chunks (small, large)	L	L	L	L	L	L	L	L	L
Concepts external to the map	Y	+	+	+	+	-	Y	+	Y
Gave attention to small detail	+	+	+	Y	+	+	o	o	+
Revealed knowledge of the area	o	+	+	o	o	+	o	o	+
Searched for detail in the area	o	+	+	o	o	+	o	o	+
Strategies employed by map readers									
Main regions identified, then subdivided	+	+	+	+	+				
Distinctive regions, then others						+	+	+	
Physical regions, then human regions									+

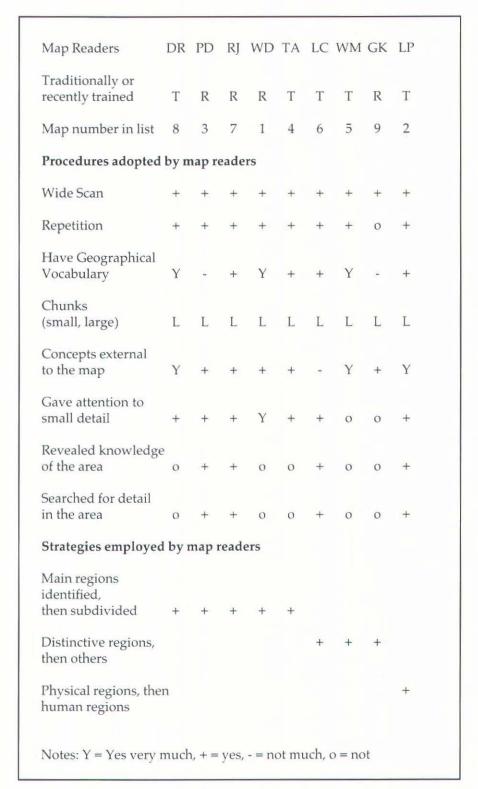Notes: Y = Yes very much, + = yes, - = not much, o = not

Table 1. Summary of Results of Regional Division on Maps

"Three out of nine geographers made extensive use of concepts external to the map."

4. Three out of nine geographers made extensive use of concepts external to the map. These were the individuals with the longest experience of map use. They frequently speculated on explanations for patterns and associations observed on the map. For example, industrial history was invoked to differentiate the dense valley-bottom settlement on the

Lancashire/Yorkshire border with water-power sites for 18th century textile production. The same very experienced map user pointed out the routeways through the Pennine hillcountry diminished the sharp distinction between Lancashire and Yorkshire by permitting movement along lines of communication. The very experienced geographer reading the Kidd's Beach map saw evidence of White planning for Blacks in the imposition of a planned landscape, wiping out a traditional economic/cultural landscape of no significance for the White dominated political economy.

5. All of the nine map users were from time to time attracted to unusual or curious details on their sheets. Examples range from two or three very small, but obviously locally important hills rising from the otherwise flat alluvial plain intersected by the Waimakariri, to the outlier of the steel industry separated from the main industrial region on the Belgian frontier with France, to the deep and narrow waterless channel across the alluvial fan on the Bavarian map which suggested sub-glacial water flow.

"All of the nine map users were from time to time attracted to unusual or curious details on their sheets."

6. Only four out of the nine acknowledged and displayed knowledge of the area on the maps they were reading. They also spent some time searching for features they expected to encounter. Of these four, one knew the city of Johannesburg but had not looked at this map, but rather like the air traveler arriving at a familiar place expected to be able to see the site of Sophiatown, a Black township demolished under apartheid. Another who had just visited Barcelona for the second time in three months looked for the Parc Guâll designed by Gaudi, the five motorway rings around the city and the area "where the bourgeoisie live" on the hills above the Autonomous University, which she had visited. The third had visited the region by bicycle in her childhood and could obviously recall those journeys and landscapes. The last expected to find an escarpment but was frustrated by the industrialization which obscured the rather discontinuous feature.

7. Three strategies can be discerned among the nine when their approach to regionalization is examined:

(a) Decide main regional divisions at the outset and then fill in the detail, subdividing some of their main regions when distinct subdivisions were perceived. The process tended to be iterative, beginning with a rough division which was sometimes modified in detail. Tracing the boundaries of regions by hand was often a component of the map-reading exercise. One subject drew a sketch map to conclude his account. This group included both very experienced and less experienced map users. (5 subjects.)

"Three strategies can be discerned among the nine when their approach to regionalization is examined . . ."

(b) Look for physical regions first and then switch to other criteria on which to base the regional division. The sole subject to use this method (preferred by Garnett, 1935) arrived at the same conclusion as the author of this paper, who was observing and prompting.

(c) Isolate the most distinctive area, which was generally rather smaller and certainly less typical of the map as a whole. Then return to the apparently more typical and homogeneous area to find that it could be subdivided, and sometimes subdivided again. Those who employed this strategy included the most and the least experienced. The most experienced map user began by identifying the region he happened to have

studied on the ground, being drawn straight away to it before noticing what was depicted elsewhere. (3 subjects)

CONCLUSIONS

1. Experienced map users sought to "see the wood from the trees" or distinguish the salient patterns.
2. Experienced map users who continued to use a rich geographical vocabulary for features at different scale levels appear to get more from the map.
3. Experienced map users made more use of larger, more complex chunks. This is in line with the suggestion of Gilhooly et al (1988) that the underlying schemas of more highly skilled map users were richer and more complex.
4. The most experienced map users employed concepts external to the map itself, which deepened their understanding of the landscapes represented on the maps. See Kulhavy et al (1992).
5. Any map user, whether experienced or not, can be distracted by unusual, exceptional details.
6. A direct knowledge of the ground may prove helpful, but too much may be a handicap.
7. No simple relationship between experience and region-dividing strategy was seen. This may reflect differences between the landscapes on the maps used.

"A direct knowledge of the ground may prove helpful, but too much may be a handicap."

IMPLICATIONS

This qualitative survey generally bears out how important expertness is in map reading and vindicates the views expressed in military map-reading manuals (see Board, 1984 references to War Office). Further research is required to disaggregate the effects of expertise and ground knowledge. It would be wise to restrict the test maps to those of one series in one country. This would make it easier to control the type of map-using training and experience. It must be admitted that some areas are more easily divided into regions than others, providing another argument for further testing on the same map. This would allow one to see whether there were still different strategies in regional division.

Given that one were able to distinguish between the more experienced and the less experienced map users, degree of knowledge of the area on the map might be another factor to take into account in a further study. While establishing the degree of map-using experience would require some in-depth interviewing, knowledge of the area is probably simpler to determine. However, such knowledge may be from direct field experience, or solely second-hand from documentary sources. This could be a further factor to take into account in selecting map users. It might also be valuable to establish whether subjects in a future study had previously undertaken such a regional division on maps. Cartographic knowledge as such needs to be defined more clearly and may be less relevant than geographical knowledge to success in map reading. By this is meant a knowledge of mapping beyond the understanding of what symbols and lettering styles signify. That those who are expert have acquired considerable cartographic knowledge may have no bearing on reading and interpreting maps.

"Cartographic knowledge as such needs to be defined more clearly and may be less relevant than geographical knowledge to success in map reading."

If the division of areas into landscape regions is regarded as helpful (e.g. to provide strata for surveys at a more detailed level) it is worth examining more closely the overall strategies adopted by map users in regionalization. If it could be shown that one strategy of regional division was more common than another, one might with greater confidence advise those who wish to generate visualizations from GIS's millions of complex combinations to begin with an examination of a detailed topo-

graphic map as a precursor to the selection of variables from a data base. One could rely on a formula such as those formerly used by textbooks on map interpretation, e.g. Garnett (1935, pp. 9 & 25) dealing with the physical features first, then the human responses to them followed by the regional synthesis. Research might show that an another approach would suggest a more effective way of selecting significant variables.

"One could rely on a formula . . dealing with the physical features first, then the human responses to them followed by the regional synthesis."

REFERENCES

Board, C. 1984. Higher-order Map-using Tasks: Geographical Lessons in Danger of Being Forgotten. *Cartographica*, 21(1) 85-97.

De Lucia, A. 1976. How people read maps: some objective evidence. *Proceedings*, American Congress on Surveying and Mapping, 135-44.

Dickinson, R.E. 1953. *Germany: a General and Regional Geography*. London: Methuen.

Edwards, G. 1991. Spatial knowledge for image understanding. in D.M. Mark & A.U. Frank, (editors) *Cognitive and Linguistic aspects of Geographic Space*, 295-307. Amsterdam: Kluwer Academic.

Geikie, A. 1901. Use of Ordnance Survey maps in teaching geography. *Geographical Teacher*, 1, 61-67.

Gilhooly, K.J., Kinnear, P.R., Green, C. & Wood, M. 1988. Skill in map reading and memory for maps. *Quarterly Journal of Experimental Psychology*, 40A(1) 87-107.

Head, C.G., 1984. The map as natural language: a paradigm for understanding. *Cartographica*, 21(1) 1-32.

Herbertson, A.J. 1902. On the one-inch Ordnance Survey map with special reference to the Oxford sheet. *Geographical Teacher*, 1, 150-66.

Kinnear, P.R. & Wood, M. 1987. Memory for topographic contour maps. *British Journal of Psychology*, 78, 395-402.

Kulhavy, R.W., Pridemore, D.R. & Stock, W.A. 1992. Cartographic experience and thinking aloud about thematic maps. *Cartographica*, 29(1) 1-9.

MacEachren, A.M. 1995. *How Maps Work: Representation, Visualization, and Design*. New York: The Guilford Press.

Muehrcke, P.M. 1982. Maps in Geography, in L. Guelke (editor), Maps in Modern Geography, *Cartographica*, 18(2) 1-41.

Olson, J.M. 1976. A coordinated approach to map communication improvement. *The American Cartographer*, 3(2) 151-9.

Smith, C. Babington, 1957, *Evidence In Camera*. Chatto & Windus, Ch. 9, esp. p. 210.

Thorndyke, P.W. & Stasz, C. 1980. Individual Differences in Procedures for Knowledge Acquisition from Maps. *Cognitive Psychology*, 12, 137-175.

Wood, M. 1993a. Interacting with Maps, pp. 110-123 in Medyckyj-Scott, D.J. & Hearnshaw, H. (eds) *Human Factors in Geographical Information Systems*: Belhaven Press, 111-123.

Wood, M. 1993b. The traditional map as a visualization technique, in Hearnshaw, H.M & Unwin, D.J. (eds) *Visualization in Geographical Information Systems*. Chichester: John Wiley pp. 9-17.

Maps used in this study:

1. Bavaria. Bayerisch Landesvermessungsamt München. Topographische Karte 1:50,000. L-8136 Holzkirchen. 1962.

2. Belgium. Institut Géographique National. Carte Topographique de Belgique. 1:50,000. 71-72 Virton-Houwald. 2nd edition. 1990.

3. Catalonia. Institut Cartogràfic de Catalunya. Mapa Comarcal de Catalunya. 1:50,000. Barcelones i el seuentorn. 13.1994.

4. France. Institut Géographique National. 1:50,000 Série Orange 3141 Carpentras. 5th edition. 1989.

5. Great Britain. Ordnance Survey. 1:50,000. Blackburn & Burnley sheet 103. First series 1973.

6. New Zealand. Department of Lands and Survey. NZMS1 1:63,360 sheet S75 Waimakariri. 3rd edition. 1969.

7. South Africa. Trigsurvey. 1:50,000 2628AA Johannesburg. 4th edition. 1970.

8. South Africa. Chief Directorate Surveys and Land Information. 1:50,000 3327BA&BC Kidd's Beach. 3rd edition. 1994.

9. Switzerland. Eidgenossische Landestopographie. Landeskarte der Schweiz. 1:50,000. 243 Bern. 1975.

*See for example Birch, 1968, Map and Photo Reading, pp. 59-60, which urges that the description of a map area should start with the physical landscape relating human settlement to it, and, "if the area subdivides into distinct types, deal with one at a time and give each a suitable name . . . ."

** A classic instance of this process, albeit carried out under wartime pressures, is the interpretation of Germany's secret V weapon sites (Smith, 1957).