TRANSPORT AND REGIONAL DEVELOPMENT IN HISTORICAL PERSPECTIVE: A COMPUTERIZED ATLAS ON THE HISTORY OF TRANSPORT IN THE DANISH AND NORTH-GERMAN REGION OF SCHLESWIG-HOLSTEIN DURING THE NINETEENTH CENTURY

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Abstract

The use of computerized cartography has been applied to the creation of a historical atlas, outlining the development of transport in the Danish, later German region of Schleswig-Holstein during the nineteenth century. Consisting of some forty colored map, the atlas explores themes like the modernization of the transport infrastructure (roads, waterways, seaways, ports, railways) and the gradual networking of these separate modes of transport in a more unified transport system. Other maps explore the performance of the network by making use of statistical analysis in conjunction with thematic cartography. Due to the region's importance as a maritime province, special attention has been paid on waterborne traffic and ocean-going shipping. In terms of spatial analysis, the atlas looks at the region as a whole, at sub-regions, at the level of the city within the region, and at the region's place within Germany and Northern Europe. Computer-assisted cartography has been accomplished with the mapping program THEMAK2.

1 Background and aims of the project

Germany's most northern state of Schleswig-Holstein, unlike other *Länder*, does not possess an historical atlas. As a consequence, a few years ago a group of historians and geographers associated with the Schleswig-Holstein Historical Society were charged with the task of exploring possibilities of putting together an atlas on the basis of recent historical research and of employing computer-based cartography for such a project. Since at about the same time a project on the history of transport in Schleswig-Holstein had got underway, in which some of the persons involved with the atlas likewise participated, a decision was taken on creating an atlas on the history of transport in Schleswig-Holstein during the nineteenth century as a kind of pilot project for the larger atlas effort. Although thus limited in its thematic scope, and likewise in the number of maps

[1] This paper reports on a collaborative effort. The author wishes to acknowledge the participation of Walter Asmus (Husum), Ingwer E. Momsen (Kiel), and Joachim Robert Moeschl (Berlin).

it could contain, the envisaged "Transport Atlas" soon became a project in its own right. While its authors did not lose sight of the original idea of a pilot project as a vehicle for gathering valuable knowledge and data for an eventual full-fledged project, they were also increasingly convinced that the Transport Atlas itself was going to create an impact by adding to our knowledge on the economic history of the region, and by solely relying on computer-based cartography, which - at least for a historical subject matter - was new and, in the German case, truly innovative. The Transport Atlas has meanwhile been completed and is available in book form.[2] Prospects for a CD-ROM publication are currently being explored, and work on the larger atlas will, pending further financing, continue as well.

2 Underlying concept and content of the atlas

The basic idea of the atlas is to visualize the historical development of the transport sector of a regional economy in a temporal and spatial context. In terms of time span, the atlas covers the period 1770 to 1914, in terms of territorial extent the duchies of Schleswig and Holstein (until 1867 under Danish rule), subsequently the Prussian province of Schleswig-Holstein, which as of 1871 became part of the German Empire. Adjacent territorial entities like the Hanseatic cities of Hamburg and Lübeck, or the duchies of Oldenburg and Mecklenburg-Strelitz are included as well if required by the theme of the map. These territorial changes are captured in two political maps at the beginning of the atlas. They show the political and administrative divisions of the region in 1830 and 1914 (in relation to today's situation) and are meant as an aid to the reader, particularly to those not familiar with Schleswig-Holstein's complicated political history during this period.

Aside of the political maps, the atlas itself is divided into five sections, four of which present maps on the development of the transport-related infrastructure, and one focusses on the use of this infrastructure and thus on the econonic performance of the transport system. All maps are in color, most of them are of the scale 1:1.000.000, and all are accompanied by explanatory texts.

The first four sections concentrate on different modes of transport and their gradual interfacing into a transport network during the industrialization process. In the beginning focus is on the two "pre-industrial" transport modes, i.e. road and waterway. Three maps show the devlopment of the road network of Schleswig-Holstein, which was modernized beginning in the 1830s by building artificial roads using the MacAdams method (turnpikes or *Chausseen*). The following seven maps are then devoted to ports and waterways, two of which deal with two important canals built in the region to connect the Baltic with the North Sea, the Eiderkanal, opened in 1786, and its successor, the Kiel Canal (Nord-Ostsee-Kanal), opened in 1895 and to this day one of the major ship canals

[2] *Atlas zur Verkehrsgeschichte Schleswig-Holsteins im 19. Jahrhundert*, edited and compiled by Walter Asmus, Andreas Kunz, Ingwer E. Momsen. Cartography and graphical data processing by Joachim Robert Moeschl. Neumünster: Wachholtz 1995.

in the world. The importance of maritime trade in a "region between two seas" is borne out by the fact that the next five maps in the atlas are devoted to this theme. They visualize the development of Schleswig-Holstein's merchant fleet between 1777 and 1914, also taking into account technological change brought about by the invention of the steam engine. The latter theme is accentuated in the final five maps of this section, in which the story of railway-building in the region is outlined.

One major theme of the atlas is the networking of different modes of transport. The historical roots of this process can be found in the second wave of European industrial development commencing in the 1880s, which created the necessity for formerly rivalling transport systems to cooperate more closely within a joint transport net. The atlas shows the various stages of this networking process, with a series of maps focussing on bilateral links between transport modes in the region, e.g. between railways and inland waterways, roads and waterways, seaports and railways, etc. Subsequently, four maps show multilateral links, i.e. the formation of the overall network at certain reference years, at the regional level as well as - in examplary fashion - at the level of one sub-region (western Holstein) and one specific location (the port city of Flensburg).

So far all maps have viewed transport in Schleswig-Holstein from the supply side, i.e. the potential invested in the transport infrastructure. In the last section of the atlas the demand side, i.e. the utilization of this infrastructure comes into focus. For reasons of space this could be done in examplary fashion only, although a wide variety of themes are presented in map form: the performance of ports and railway stations by charting arrival frequencies and goods traffic, the performance of canals, both regionally and set into a larger European setting, and, lastly, the geographical distribution of regular line services in Schleswig-Holstein in 1863.

3 The application of computer-assisted cartography

The atlas reported on here is a true "computer atlas", for all the maps it contains were created with the instruments and programs of graphical data processing. All maps have been digitized, manual techniques have not been employed. We have used the mapping program THEMAK2, which was originally developed at the Free University of Berlin and has, in the meantime, become a commercial product as well.[3] The program allows the digital mapping of *lines* (borders, coastlines, waterways, railway lines, etc.), *areas* (political entities, lakes, islands, etc., and *locations* (ports, railway stations, etc.) and makes it possible to link statistical infomation (e.g., amount of goods transhipped at a port in a given year) to points, areas, or lines.

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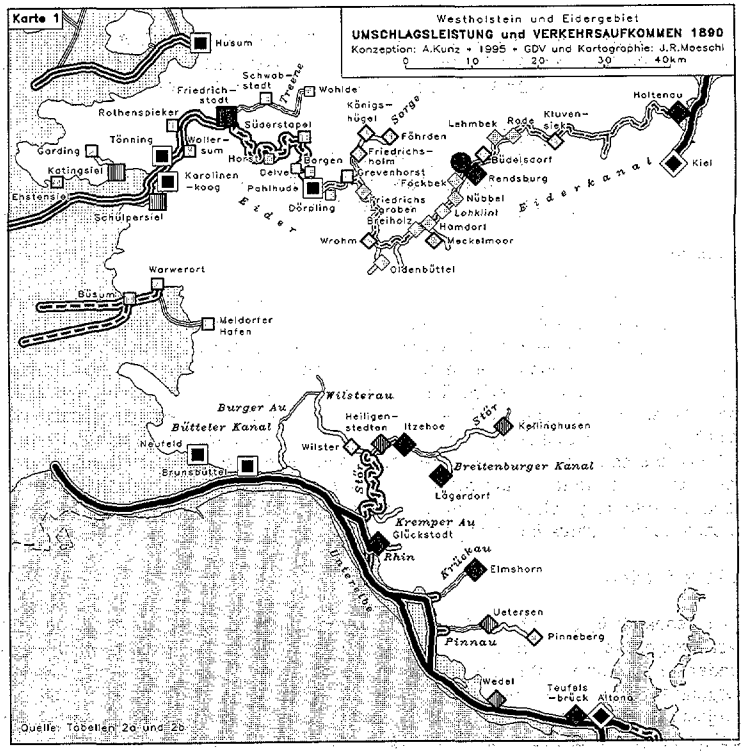
[3] We gratefully acknowledge the assistance extended to us by Professor Ulrich Freitag of the Department of Geography of the Free University of Berlin, and by the Berlin-based firm GraS-Graphical Systems which handles THEMAK2 as a commercial product.

Initially, a set of basic digital maps of the region was generated, using a variety of printed maps, topographical descriptions, and other relevant information as sources. Special attention had to be paid to the western coast line of the region, which over a period of 150 years underwent considerable changes due to losses and reclaiming of land. The geometry files were then linked with attribute files in order to generate thematic maps. Attribute files were processed in two different ways, either by way of digitizing using a map as a source, or at the screen for data which stemmed from other sources than cartographical ones. Once stored, all data could be used for new themes as well and thus greatly facilitated the generating and plotting of additional maps.

One advantage of computer-assisted cartography is that it allows for a high level variabilty with regard to the content and the layout of the maps. Size is a good case in point. On the basis of identically-structured data files it was possible to generate and plot map series of Schleswig-Holstein, in which the region appears either in its entire extention as a full-page map (scale 1:1.000.000), as a quarter-page map (scale 1:2.000.000), or as a portion of the full area (variable scale). Zoom effects allowed for the smooth construction of excerpt maps. THEMAK2 also offers a great variety of diagrams, geographical signs and symbols, colors, and fonts, which was helpful in devising a general legend for the atlas.

A sample map

The map appearing on the next page is the black and white version of a similar one contained in the atlas in color. It is one of the maps depicting a sub-region of Schleswig-Holstein, i.e. the south-western part of Holstein. The theme of the map is the performance of ports in this area in 1890. Seaports as well as inland ports are included. Owing to the source used for the port data, three different types of information is given to the viewer: For ports situated along North Sea and in the western part of the Eider river, the level of the intensity of traffic is depicted in squares representing the size (tonnage in cubic meters) of all ships cleared in these ports. For inland ports along the Elbe, the eastern section of the Eider, the Eider-Canal, and the Kiel Fjord the volume of transhipments (weight in metric tons) is represented by a diamond-shaped sign. For one port, Rendsburg, the passage of freight (in metric tons) is given and represented in the legend by a circular sign. As additional information, the capacity of inland waterways and coastal seaways is represented by line symbols ranging from seaways with a capacity to take in ocean-going vessels with a displacement of more than 3000 tons to small inland waterways accepting barges of less than 25 tons. One message given by this map is that in 1890 there still existed high level of activity even in small ports along the Eider and the Eider Canal. When five years later the Kiel Canal was opended, traffic in many of these small ports and loading places all but ceased, because even more than its predecessor the new canal was geared toward transit of freight on ocean-going vessels between the North Sea and the Baltic.



Raumgehalt der ein- und ausgelaufenen Schiffe: (in Kubikmetern)

- mehr als 100 000 cbm
- 50 000 cbm bis 100 000 cbm ausschliesslich
- 10 000 cbm bis 50 000 cbm ausschliesslich
- 1000 cbm bis 10 000 cbm ausschliesslich
- weniger als 1000 cbm

Hafenumschlag in Tonnen:

- mehr als 100 000 t
- 10 000 t bis 100 000 t ausschliesslich
- 5000 t bis 10 000 t ausschliesslich
- 1000 t bis 5000 t ausschliesslich
- weniger als 1000 t

Durchgang in Tonnen:

- 10 000 t bis 100 000 t ausschliesslich

Wasserstrassen für Schiffe mit einer Tragfähigkeit von:

- mehr als 3000t (=Seeschiffahrtsweg)
- 1200t und mehr
- 600t bis 1200t ausschliesslich
- 400t bis 600t ausschliesslich
- 200t bis 400t ausschliesslich
- 100t bis 200t ausschliesslich
- 50t bis 100t ausschliesslich
- 25t bis 50t ausschliesslich
- weniger als 25t

maps was 204 m. With visual interpretation procedures using a LANDSAT MSS image, the main morphogenetic and morphostructural units were delineated.

A main step in the methodology to delineate environmental units was the User-GIS Interactive Process of *on-screen digitizing*. This GIS capability allows one to *draw* segments with the digitizer's cursor on a raster image backdrop (an image that is displayed on the graphics screen). In this process, different thematic information layers were selected and overlaid on the hillshading map. Those thematic units led us to have more certitude in delineating the environmental units. Figure 2 shows an example of the Interactive Process User-GIS using *on-screen digitizing* capability. It is a detailed window of the study area (San Lucas Cape). The black lines are environmental units boundaries. White lines are soil units. The hillshading map was used like backdrop image.

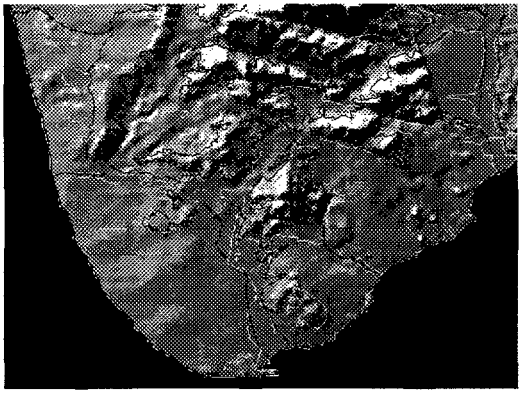


Figure 2: Interactive Process User-GIS using *on-screen digitizing* capability. San Lucas area.

The landscape unit map was cross-tabulated against several thematic maps to obtain a digital database that describes area and cover percentage of each thematic class for each landscape. The landscape units map and its database led, in further phases, to the definition of land use suitabilities based on an environmental land-management approach using multivariate analysis techniques.

4 Results

Figure 3 shows 5 ecogeographic systems and 32 landscapes delineated for the Municipality of Los Cabos by means of the method described. The inside number in each unit corresponds to the last two digits of the complete landscape code. Each ecogeo-system have been showed in different gray scale. Table 1 shows a biophysical description of landscape units.

5 Conclusions

The geomorphologic approach used was useful in defining the environmental units in this study of ecological or environmental land management. The use of GIS was useful in delineating the environmental units, mainly in the Interactive User-GIS process. As a final result, 32 landscapes units were classified into taking out four management policies: conservation, use, restoration, and protection. 57 physical, biological, and socioeconomic

Table 1: Biophysical description of environmental units (location in Figure 3, after [7]).

Land-scape	Land-form	Area (km^2)	Maxim Altit (m)	Minim Altit (m)	Avg Slope(°)	Temp (°C)	Rainfall (mm)	Geology	FAOSoil Class	Vege-tation
050101	Pm	457	600	1	1	23	250-275	Tpl(lu-ar)	Regosol	MSSi
050102	Pm	143	517	1	1	23	125-250	Q(cg)	Regosol	MSSi
050103	Hs	154	780	20	8	23	250-275	T(Gr)/Tm(Vc)	Lithosol	SBC
050104	Pm	339	600	1	4	>24	250-275	K(Gr)/Q(cg)	Regosol	MSSi
050105	Pm	176	514	1	1	23	250-275	K(Gr)/Tpl(lu-ar)	Regosol	MSSi
050106	Pm/Hs	75	200	1	4	>24	250-275	K(Gd)	Lithosol	SBC
050107	Hs	56	500	129	3	>24	250-275	K(Gr)	Regosol	SBC
050301	Pm	204	500	1	2	23	275-350	Q(cg)	Regosol	MSSi
050302	APl	74	326	1	1	23	275-350	Q(al)	Fluvisol	MSSi/Vr
050303	Pm	36	500	150	3	23	275-350	Q(cg)	Regosol	SBC
050304	APl	102	400	1	1	23	275-350	Q(al)	Fluvisol	SBC/MSSi
050305	Pm	151	458	80	2	23	275-350	Q(cg)	Regosol	MSSi
050306	Pm	40	300	36	2	23	275-350	Q(cg)	Lithosol	MSSi
050401	APl	34	384	1	1	23	275-350	Q(al)	Fluvisol	MC
050402	Pm/Hs	90	400	1	4	>24	250-275	K(Gd-Tn)/T(Gr)	Regosol	SBC
050403	Pm	177	539	1	4	23	250-275	T(Gr)	Regosol	SBC
050501	Pm/APl	221	600	1	3	23	250-275	K(Gr)	Regosol	MSSi
050502	Pm/Hs	82	384	1	4	23	250-275	M(Met)/K(Gr)	Regosol	MSSi
050503	Pm	224	500	1	3	23	250-275	T(Gr)	Regosol	MSSi
050701	Mnt	96	1000	120	13	23	350-450	K(Gd-Tn)	Lithosol	SBC
050702	IMVal	55	900	120	8	21	350-450	K(Gd-Tn)	Lithosol	SBC
050703	Mnt	75	1400	200	13	23	350-450	K(Gd-Tn)	Lithosol	SBC
050704	ErVPm	169	1000	96	7	23	350-450	K(Gd-Tn)	Lithosol	SBC
050705	Rg/Cny	455	1910	180	17	21	450-600	K(Gd-Tn)	Lithosol	SBC
050706	Mnt	61	900	174	8	23	275-350	K(Gd-Tn)	Lithosol	SBC
050707	IMVal	37	1150	200	9	19	350-450	K(Gd-Tn)	Lithosol	SBC
050708	Cny	20	1433	363	12	19	450-600	K(Gd-Tn)	Lithosol	SBC
050709	Cny	23	1450	384	10	19	450-600	K(Gd-Tn)	Lithosol	SBC
050710	Rg/Cny	701	2100	190	15	23	450-600	K(Gd-Tn)	Lithosol	SBC
050711	Cny	27	1900	200	11	18	350-450	K(Gd-Tn)	Lithosol	SBC
050712	Pm/Hs	148	900	1	5	23	125-250	Q(cg)/K(Gd-Tn)	Regosol	SBC
050713	VPm/Hs	48	700	263	4	23	350-450	K(Gd-Tn)	Regosol	SBC

Landform Key second column: Pm= Piedmont, Pm/Hs= Piedmont and Hills, Hs= Hills, APl= Alluvial Plain, Pm/APl= Piedmont and Alluvial Plain, Cny= Canyon, Mnt= Mountains, Rg/Cny= Ridges and Canyons, IMVal= Intermountains Valleys, ErVPm= Erosive Valleys in Piedmont, VPm/Hls= Valleys in Piedmonts and Hills. ***Geology Key***: K(Gd)= Cretaceous (Granodiorite), K(Gd-Tn)= Cretaceous (Granodiorite-Tonalite), K(Gr)= Cretaceous (Granite), M(Met)= Mesozoic (Metamorphic Complex), Q(al)= Quaternary (Alluvial Deposits), Q(cg)= Quaternary (Conglomeratic Deposits), T(Gr)= Terciary (Granite), Tm(VC)= Miocene (Volcanoclastic Deposits), Tpl(lu-ar)= Pliocene (Shale and Sandstone Deposits). ***Vegetation Key:*** MSSi= Sarcocaulescent Shrub, SBC=Tropical Deciduous Forest, Vr=Riparious Vegetation, MC= Crasicaulescent Schrub.

System 1 Ridges and Piedmont "La Rivera", includes landscapes 050101-07. ***System 3*** Piedmont and Alluvial Plains "*Sn. José-Santiago-Buenavista*, includes landscapes 050301-06. ***System 4*** *Piedmont and Alluvial Plain "San José del* Cabo", includes landscapes 050401-03. ***System 05*** Piedmont and Hills "La Tinaja" includes landscapes 050501-03. ***System 07*** Ridges and Canyons "Sn. Lázaro" includes landscapes 050701-13.

variables were selected and analyzed by multivariate techniques. The results of this research, in further phases, led us to define and cluster four sets of environmental units with different land use suitabilities.

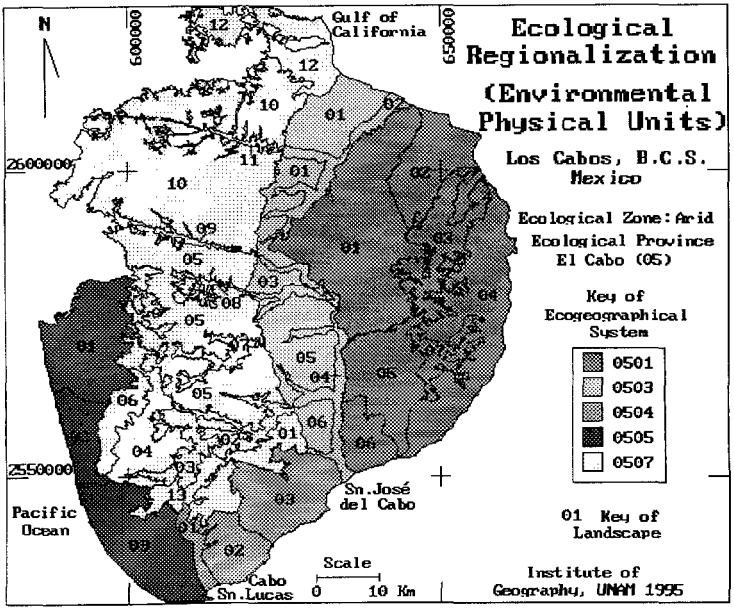


Figure 3: Map of environmental units (units described in Table 1).

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