

Chapter 5 Topographic Maps

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5.1 Introduction

A topographic map describes a place (*topos* is Greek for *place*). For a long time, they have been used for military purposes but are now used as well by the public and as a background for spatial planning and other official uses. Topographic maps are produced at many scales and in many different designs.



Figure 5.1. A topographic map at the original scale of 1:50,000. The map shows the village where the author of this chapter lives.

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The topographic maps produced by the National Mapping Organizations (NMO) are normally called official maps. Nowadays, map production is combined with building geographical databases, which are regularly updated.

The most common topographic map for rural areas is a

map at the scale of 1:25,000 or 1:50,000; in urban areas a map at a scale of 1:10,000 is normally called a city map or city plan. All those maps are very good for finding your way. That might be for hiking, berry picking or searching for mushrooms, or finding the route to a museum. In many countries, the rural maps are produced and sold by the NMO and the city maps by each municipality.

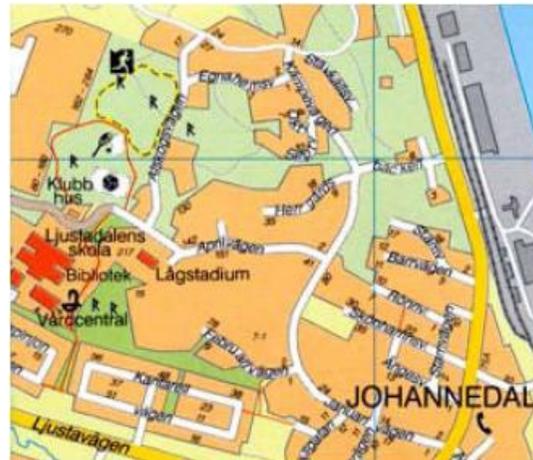


Figure 5.2. A city map at the original scale of 1:10,000 of Sundsvall, Sweden. Note that the map also contains information about a jogging track and ancient monuments and a symbol for a drug store.

Source: Stadsbyggnadskontoret, Sundsvall, Sweden.

For car navigation, smaller scales such as 1:250,000 are used. For digital car navigation, very detailed topographic information is needed. We will talk about that later.

All maps pictured on this page can be used for planning purposes and as background for other maps. However, in many countries, topographic maps at the scales of 1:25,000 to 1:100,000 also depict military objects and for that purpose these maps have been restricted from

public use. In most countries, military objects are overlaid to a special military version that can be restricted, and the topographic map is free for public use.



Figure 5.3. A road atlas of Sweden at the original scale of 1:250,000.

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5.2 Data Collection

Since most maps nowadays are digital, we will focus on digital methods for both data collection and production of topographic maps.

The first thing you have to decide when making a map is what geodetic system you want to use. There is some software that is free to use (see Chapter 15). Normally, the national mapping organization (NMO) is using software that would be costly for private persons. The NMO is normally using a geodetic network connected to the world geodetic network WGS84 (see Chapter 9).

The next thing to decide is the scale. If you go for a scale at 1:50,000 as shown in figure 5.1, you should use aerial photos or satellite images. An aerial photo taken from

the elevation of 13,000 meters gives a resolution of 1:10,000. Before you can use an aerial photo for mapping, it has to be transformed to an orthophoto map (see Figure 5.4). That is made by each NMO or by companies in the business and implies that photo gets a correct scale over the whole area. You can try to get an orthophoto from your NMO but that is not normally free of charge. You can also go to Google Maps where you can look at topographic maps of all spots of the world.



Figure 5.4 shows an orthophoto of central Stockholm, Sweden, in the year 2009.

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From an orthophoto map, it is easy to find roads, lakes, rivers, built-up areas and different types of land use. Since all information nowadays is digital, you must also for mapping use a database with geographic data. Designing a database is rather tricky but further information is given in Chapters 3 and 15.

One way to collect data is to scan older maps and digitize features, for instance, administrative borders in these maps, but most information can be digitized in the orthophotos. It is also important to classify the information. Roads are of different importance and should be classified with motorways at the highest level

and paths for walking at the lowest level. Since the topographic maps were used by the military, the roads were categorized according to military purposes. A narrow road was a road where it was not possible to turn with a horse and a wagon. It was the same for water streams. A stream that an infantry soldier could cross without problems was depicted with a single line, while a stream that needed a bridge was marked with double lines in blue to indicate the water between the two lines.

5.3 The Legend

All maps need a legend (an explanation of the signs and symbols used on the map), and so do topographic maps. It is rather common to start with communications with the group roads, rail and air, followed by power lines for electricity and gas. The next group might be single objects like places for swimming and camping and location of buildings like castles, farms, greenhouses, homes, religious buildings, and so on. In built-up areas, it is not possible to indicate all single houses. Blocks with different construction types must be indicated mostly in accordance with the height of the buildings. Closed blocks in city centres must also be indicated.

Administrative borders and lakes and streams are two other groups. Borders shall be indicated with their function and streams with their size. A big and a troublesome group of data to represent on the map is land cover and land use. Some land cover like forest has different definitions in different countries. In Northern Europe, there are not so many trees per area like in a tropical forest, which means that the density of the forest must be compared considering the location. Open spaces in the forest can be shown for some years and will later be changed to young forest. Wetlands are again a different land use type and can be classified by experts. Land use such as arable land changes over time. In the map, it is usually impossible to show different crops, but

in areas with less intensive agriculture, some lands are not continuously used and tend to be bushy.

Changes in arable land, forest and road conditions must be checked in the field before printing. There is a standard in topographic mapping to first produce a good copy as soon as possible at the office before going out for field checking. Office work is cheaper than sending out people for fieldwork.

5.4 Relief Representation

The most common way to show relief is by contour lines showing the height elevation. Laser-scanning aerial cameras nowadays also can register elevation and give the background for calculation of contour lines and other details in the landscape such as constructions and ditches. Also tracks in wood can be detected. Laser data are collected as point clouds that give possibilities to calculate elevation at a very good accuracy. High resolution laser data have many applications also in climate applications for finding areas with risk for flooding and for land slide. An example of aerial laser-scanning is shown in Figure 5.5.

A special technique for showing elevation is hill shading, where you illuminate the landscape from normally the northwest and get a shadow in the southwest (see Figure 5.6).

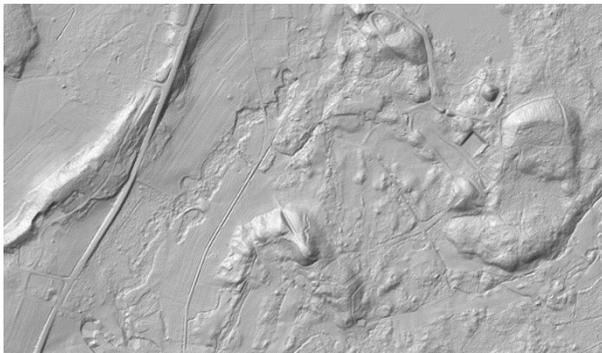


Figure 5.5 shows laser data at a grid of 2 meters collected by Lantmäteriet (The National Land Survey of Sweden) that will set up a new national elevation model with an accuracy better than 0.5 meter.
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Figure 5.6 shows an example on hill-shading example from the mountain map of Sweden.
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5.5 Generalization of Maps

Automatic generalization (See also Chapter 4, section 3.7) is rather difficult but many NMOs start topographic mapping at the scale of 1:25,000 or 1:50,000 and then create smaller scales successively. The US Geological Survey in the United States of America is maintaining such a program in cooperation with experts from different universities (http://cegis.usgs.gov/multiscale_representation.html).

Note that 1mm in a map at 1:50,000 is 50meters in reality. That also implies that we must think of generalization.

5.6 Maps for Navigation

The maps shown in Figures 5.1–3 may all be used for navigation or driving. In chapter12, maps for orienteering and geocaching are described. However, mobile phones and cars can include GPS receivers and information systems for navigation. There are also systems for tracking dogs where the hunter can follow the location of the dog.

There are many operators for car navigation systems. Each operator must have a detailed topographic map that also includes addresses, names, and locations of restaurants, hotels, shops, and so on. It is hard work to keep such a database up-to-date.

Many of the mobile phone operators have included GPS and maps in order to increase their income for advertisements from companies that will be easier to find also inside shopping centres. However, GPS location indoors is not possible, but there are other solutions with sensors that can replace satellites.

5.7 Topographic Maps as Background Maps

All thematic maps need topographic maps as a background. The most common one is the weather map shown every day in newspapers and on the TV set. For private use, you may find maps for biking (see Figure 5.7) or canoeing.

The geographic database behind the topographic map is organized in layers as described in chapter 3. The layers should be organized so that it would be possible to produce a topographic map as background for a city plan. Figure 5.8 shows an urban plan with an orthophoto as a background. Many municipalities are now using the Internet for distributing plans to the public for comments.



Figure 5.7. A map for biking. Red lines show paths for biking and dotted red lines proposed roads for biking in mixed traffic. Original scale 1:50,000.
Source: City of Landskrona, Sweden.



Figure 5.8 showing a city plan for Kabul—City of Light Development area and concept plan. The blue shows the old city, yellow shows housing and red the commercial district. The background is an orthophoto map. Source: Wikipedia (urban planning).

Property maps can also use topography as a background to property boundaries and administrative boundaries. The reasons for constructing property maps are not only to know the location of the property but also to find out the value of the property for tax purposes. In Sweden, property mapping started in 1628 with an order from the King of Sweden. One person got the task and started to train land surveyors in measuring and mapping. Later on, cartographic rules were developed. The maps were called geometric maps and were produced at the scale of 1:5,000. The maps were used when the division of farm land was reformed to be a more efficient division to allow for new farming techniques. The geometric accuracy of these maps is very good, and they are still valid in questions of land disputes. Most countries have had the same development. For more information, you can contact the NMO in your country.

5.8 Geological Maps

Geology maps are thematic maps, generally displayed in Chapter 6. Geology mapping and topographic mapping

are closely related since geological maps must have the correct topography as a background.

Geology may also be produced in the form of atlases. An example is the Physical Atlas of China (Ke Liao, 1999). It contains geological and geophysical maps, geomorphological maps, climatic maps, hydrological maps, soil maps, biological maps, maps on natural resources and disasters, and finally maps on nature utilization and conservation including land use. Of public interest is the geological map showing bedrock and the soil map. The topographic map and the bedrock map are good tools for finding minerals, but you need to study a lot before practicing. The soil map can give farmers or farm buyers information on what can be grown and how to fertilize the land.

5.9 Required Map Information

All topographic maps must include the following information:

- *Title* shows the name of the. Further information needed are the area of the map, the map subject and the actuality of the content.
- *Legend* shows the meaning of the map symbols and the connection to the database.
- *Scale* shows the scale of the map either by numbers or by a figure showing the length (e.g. of one kilometre).
- *Geodetic network* showing the position of a point in the map. The network must be included if the map shall be used for navigation.
- *Projection* shows how points in longitude and latitude are transferred to the plane coordinate system (See Chapter 9).
- *Author, publisher and references* tell who has made the map, who has published it and what

sources are used and which time the data represents. If some of the data has copyright, it shall also be indicated.

5.10 Historical Topographic Maps

The first known maps were found on clay plates in Babylon, but for a long period, the most common media for maps has been paper, until recently when screen maps became the most common ones. Never before have so many unique maps been published. More information on historical maps are given in Chapter 1.

5.10.1 The 19th Century

Topographic maps have always had a high military importance. For a long time, it was difficult to measure the distance in West–East. In North–South, you could use the stars and the sun to measure your position, but in West–East, you must know the time in order to get a good position. That means that cartographers also had difficulties in writing correct maps. An efficient clock was most important and the sailors very much needed a correct clock for finding the longitude. That also meant that many maps were not correct in the West–East direction.

However, topographical maps were of great importance for military purposes; military brigades were shaped both for geodesy and topographic mapping and the resulting maps became classified not to be used by non-military. Nowadays, most countries have lifted the restriction but some countries still have restrictions for private use.

To my knowledge, topographic maps from the 19th century are of high quality, and they are perfect for studying the development of the society. New versions of the topographic maps are issued regularly. For studying the development of your neighbourhood, you

can select different versions of the map at your library. That can be a good exercise in schools.

Figure 5.9 shows the present Malmö, the third biggest city in Sweden, located only some 15 kilometres east of Copenhagen in Denmark. The city extends out to the Sound (Öresund in Swedish). The harbour and industrial areas are now located on the landfill. The old industrial buildings in several floors are built such as the 72 floors Turning Torso building in Västra Hamnen (the West Harbour), a special landmark that can be seen from long distances, also from Copenhagen in Denmark.



Figure 5.9 shows a map over the city of Malmö, Sweden. Source www.openstreetmap.org visited April 27, 2014.

In Figures 5.10–12, you can see the earlier Malmö. The maps have been scanned from an historical atlas produced by a geographer (Lewan, 1985) at Lund University and a land surveyor at the National Land Survey of Sweden.



Figure 5.10 shows an orthophoto from 1985. A new industrial area has been created, and the harbour has been enlarged. Source: National Land Survey of Sweden. © Lantmäteriet Dnr R50160927_130001.

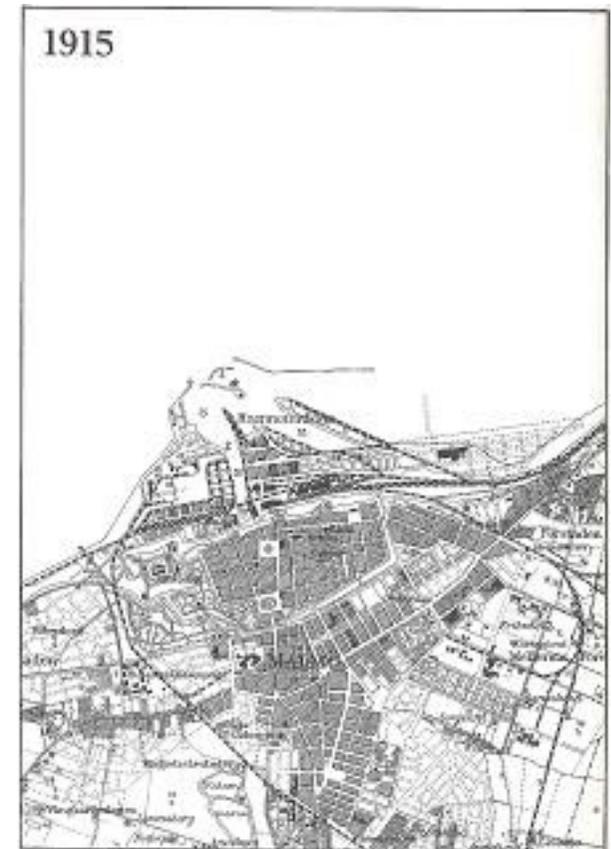


Figure 5.11 shows the topographical map of 1915, produced by the military survey of Sweden. The railroad has now been built and continues through Malmö for a connection ferry to Denmark. The area north of the centre has been filled up, giving place for a harbour and the railroad.

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Figure 5.12 shows a map from Malmö in the year 1815. The map is a part of the reconnoitre map of the province that was made in a great hurry to be prepared for a possible attack from Napoleon.

Source: Lewan, 1985. The original can be found in the Archive of the Military (Krigsarkivet), Stockholm, Sweden.

References

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Liao, Ke, (1999). *The National Physical Atlas of China*. China Cartographic Publishing House, Beijing, China.
