*Geographic Information Technology Training Alliance (GITTA) presents:*

# Presentation and Visualisation Needs

**Responsible persons: Boris Stern, Helmut Flitter, Samuel Wiesmann**

# Table Of Content

# 1. Presentation and Visualisation Needs

Wherever we look, we are faced with maps: in daily newspapers and weekly news magazines, in books, on television, on the internet, on the train, at kiosks and even on table place mats.

There is also a great variety in map types. Some are highly detailed and look like engineering drawings, others appear like hand made sketches or simple 'way-finding' maps. Some of them show the whole world, others an area not larger than your backyard.

The objective of this lesson is to demonstrate the importance of map and cartography in our pseudo-modern world, and giving an explanation of why there are so many maps and why they have such different aspects.

## Learning Objectives

- Know a short history of map use.
- Know what the objectives of specially ordered maps are.
- Know the differences between Cartography and Visualisation.
- Be able to understand why it is important to know the map users and their specific needs.

# 1.1. Demand for Maps

## Why Do we Need Maps

This learning unit introduces the concept of cartography, and why it is necessary to create maps. This learning unit serves as an introduction into the lesson "Presentation and Visualisation Needs ", and does not need prerequisites.

Maps provide a useful structure for storing geographic knowledge and experience. Without them, it would be difficult, even impossible to orient ourselves in large environments. We would be dependent on the close and familiar world of personal experience. Moreover, maps give us means not only to store spatially distributed information, but also to analyse and compare it, as well as generalise or abstract it (Southworth 1982).

## 1.1.1. Maps and Cartography

### Purpose of a Map

A map presentation largely depends on the intended use. The primary objective of maps is to store geographic information in a spatial, usually two-dimensional format. Another reason to design maps might be analytical purposes involving measuring and computing. Further purposes are used to summarise voluminous statistical data, and thereby, assist in spatial forecasting and spotting trends. Sometimes maps are simply used to visualise abstract phenomena which, would be invisible otherwise.

### What is a Map?

The *map* [1] is a graphic representation of all aspects of the cultural and physical environment. This definition includes mental abstractions that are not physically present on the geographical landscape (it is possible, for example, to map people's attitudes).

The official definition of map is: "*A map is a symbolised image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance.*" (International Cartographic Association 1996, p. 1)

### What is Cartography?

The *Cartography* [2] is the art, science, and technology of making maps, together with their study as scientific documents and works of art. In this context, we may regard all types of maps including all plans, charts, and sections, three-dimensional models and globes representing the earth or any celestial body at any scale (International Cartographic Association 1973).

[1] A map is a symbolised image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance.

[2] Cartography is the art, science, and technology of making maps, together with their study as scientific documents and works of art. In this context, we may regard all types of maps including all plans, charts, and sections, three-dimensional models and globes representing the earth or any celestial body at any scale.

## History of Map Use

### World's Oldest Map

The world's oldest map is depicted on a clay tablet from around 700 BC, which was found near Nuzi in Iraq, in Babylonian times. This map has just a size of 10x10 cm and is drawn by imagination, without any measurements, to describe a realm or the border of the known-world.


*The world's oldest map* (Chrisp 1997)

The World's oldest map: Nuzi (Iraq), 3800 BC, shows the northern part of Mesopotamia with the Euphrates, the Zagros mountains in the East and the Lebanon mountains in the West. (Chrisp 1997)

1. The Persian Gulf is drawn as a river surrounding the world.
2. The upper rectangle represents Babylon.
3. Circles around Babylon represent cities.
4. The lower rectangle represents the swampy regions of South.
5. Euphrates and Tiger Rivers flow towards the Persian Gulf.

### Navigational Maps

In Europe, compass bearings were unknown until 1300 A.C, but the position of the sun also served as a beacon for orientation. Accordingly, the beginning of surveying and navigation also represented the beginning of the history of cartography. About 200 A.C., Ptolemeus, an astronomer and geographer of Alexandria, calculated latitude and longitude of 8000 ground points. Based on his works, Arabics' carried out important further cartographic work.

However, it was the general use of the compass in the XIIIth century that allowed to establish comprehensive navigational charts: the portolans. They allowed the navigators to be guided on sea and to measure distances. On land, however, maps still remained simplistic.

*South Atlantic Portuguese chart* (Reinel 1519)

**Portolans** were drawn on parchment by navigators. They allowed them to be guided along coastlines and across the sea and to measure distances.

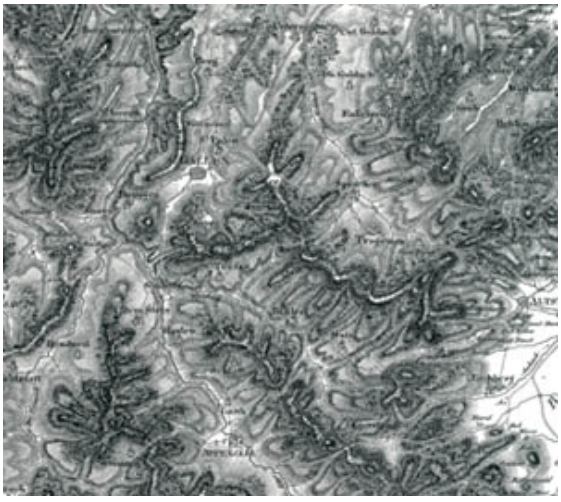
At the end of the XVth century and at the beginning of the XVIth century, the travels of Colombus, Vasco de Gama, Balboa, Magellan, and El Cano considerably widened the knowledge of earth's geography. In the XVI century, cartographers had collected enough information to represent the continents. Thus, after the sea charts began the mapping of continents.

**The Evolution of Maps**

The following series of examples shows the evolution of maps of the Appenzell countryside in Switzerland from the time of Gyger (1620) to recent days:

*Gyger map 1620* (Rusch 1999)

Extract of Gyger's maps from 1620. The average scale of the pen drawing with watercolour additions is 1:12000 with a tolerance up to 20%. What is special about this example is its orientation: towards south (Rusch 1999).



*Schwaben map 1811* (Rusch 1999)

Extract of Amann's Schwaben map from 1811. The copper engraving shows hachures whose thickness and spacing indicate the degree of slope. The original mapscale is 1:86 400 (Rusch 1999).

*General map 1890* (Rusch 1999)

Extract of Cantons' Appenzell general map from 1890 published by Wurste, Randegger and Co. It is made by the method of chromolithography where the image ink accepting and the non-printing ink rejecting areas lie in the same plane (Rusch 1999).

*Swiss national map 1:50'000, 2000, reproduced with the permission of swisstopo (BA057224)* (Bundesamt für Landestopographie 2000)

Extract of the Swiss National map 1:50 000, published by the Federal Office of Topography in 2000. Map making is nowadays done digitally using graphics computer technology. The map was originally scribed on coated glass plates but later scanned and updated digitally.

**Current Use of Maps**

As our society has become more complex, the need and use of all kinds of maps have increased. Local governments and planning agencies use them for plotting environmental and resource data. Professionals in the fields of soils, geology, and water resources use them for their daily work and planning. Public utility and engineering companies consult technical maps in order to complete their tasks. Land use maps are utilised by planners, detailed cadastral maps are indispensable for city tax recorders. Astronauts even used maps to land on the moon. The list of uses and users is virtually endless (Dent 1996).

## 1.1.2. Summary

Therefore, the cartographer should know a great deal about the disciplines covered by the maps in order to satisfy the user's demand correctly. It requires knowledge, skills and experience to express the essential characteristics of spatial data in terms of a map. Geographers represent only one group of map user. Scientists, engineers, and social scientists etc, also see the map as a valuable way to organise and express ideas. As a result of this, cartographers have to be sensitive to the mapping needs of diverse fields (ROBINSON et al. 1995)

# 1.2. Specially Ordered Maps

## What are Specially Ordered Maps ?

A new kind of cartography which deals with special themes appeared in the XVIth century, these "thematic" maps are usually based on topographic maps.
Thematic cartography has been diversified in the XIXth century with the appearance of geologic, political, or economic maps.

## 1.2.1. What are the Objectives of Thematic Maps?

**Definition**

The International Cartographic Association defines the thematic map as follows: „*A map designed to demonstrate particular features or concepts*“. Thus, in conventional use, this term excludes topographic maps. The base maps of most thematic maps, however, contain topographic elements.

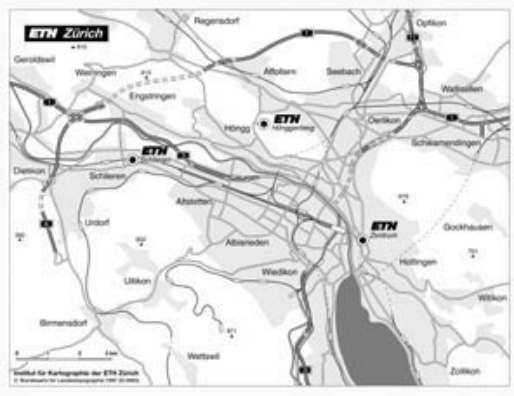
**Composition**

Every thematic map is composed of two important components: the geographic base map and the thematic overlay. The purpose of the geographic base map is to provide information about the location to which the thematic overlay can be referred.

**Examples of „Specially Ordered“ Maps**

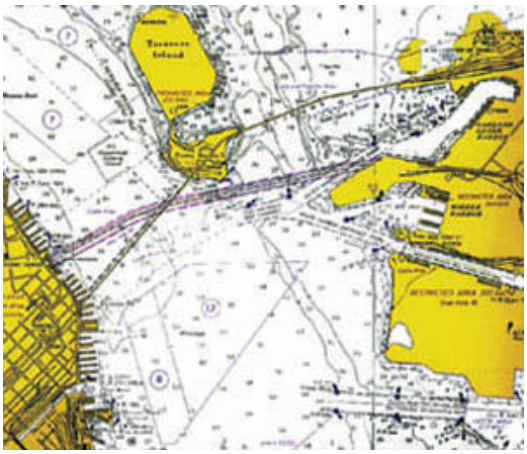
*Engelberg Ski Resort 2002* (Engelberg-Titlis Tourismus AG)

We find good examples of thematic maps in tourism: bicycling maps, museum maps, or maps of skiing resorts.
The example shows ski resort Engelberg: in the foreground there is information about ski tracks, and in the background its topography (panoramic map).




*Map for students orientation support for ETH Zurich 2002* (Institute of Cartography)

Other "special" thematic maps are e.g. transportation and communication maps, such as transport systems or station locations. In the next example, we can see a part of the transport network of Zurich city, stacked on a geographic base map. This map allows orientation for accessibility of the university by public transport for ETH students.



*Nautic chart: From San Francisco to Oakland, 1992.* (Makower 1992)

Maps which are specially designed for the needs of nautical and aeronautical navigators, are called charts. On charts, navigators plot their navigation courses, determine positions, mark bearings, etc.

## 1.2.2. Summary

Recapitulating, we retain that specially ordered maps are made to serve specific purposes, thus they have particular applications. These maps are also called special–purpose or single–topic maps.
But before a cartographer starts creating thematic maps, he or she has to know the kind of geographical inquiry to deal with. It must be analyzed how the geographic data will be presented.

# 1.3. Legally Ordered Maps

## Introduction

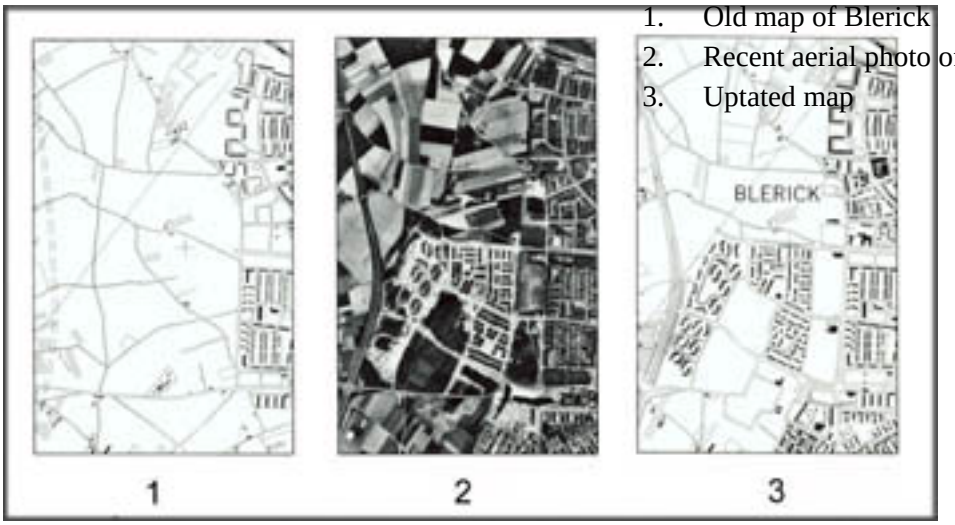
This learning unit will introduce you into the concept of legal cartography (definition, examples, etc). You do not need any prerequisites.
Cartography is often based on a legal form foundation. In Switzerland, for instance, the Federal Law Modification (November 25, 1998) about the establishment of new national maps says that the Swiss Confederation has to establish, publish and update new national maps in order to replace the current federal maps on a regular basis. Another Federal Law prescribes a recurrent updating of land use registry.

## 1.3.1. What is a Map by Legal Order?

Article 38 of the "appendices to Swiss Civil Law (ZGB) ", authorizes the Swiss Government to define a "basic plan for land registry and surveying". Furthermore, article 39 defines that the Confederation has to contribute the major part of the costs for cadastral surveying, whereas the smaller part of costs has to be shared between the Confederation and the Cantons. These articles are to be applied by the **Federal Office of Topography** (external link).
Legal cartography is not only limited to the mentioned examples in this learning unit. Another example is, for instance, land registry, which is a legal cartography of the ground ownership that is used in rather large scales. Thus, legal cartography can be considered as a cartography that is administrated by the government.

**Revision of a Topographic Map**
In Switzerland, the revision of the national topographic maps is periodically (every six years) done by the Federal Office of Topography (International Cartographic Association 1984).
The example shows a revision of a topographic map 1:25000 of Blerick county (Great Britain).

1. Old map of Blerick
2. Recent aerial photo of Blerick
3. Uptated map



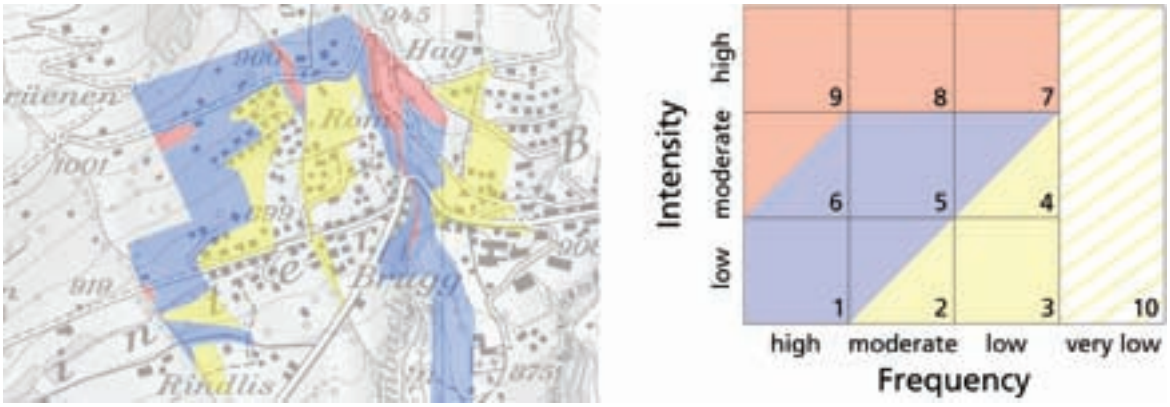

*Topographic map revision* (International Cartographic Association 1984)

### Hazard and Risk Maps

Spatial planning measures (alignment of land-use with natural conditions) can significantly reduce damage potentials. Hazard maps form the basis for these spatial planning tasks by indicating the location of hazard prone areas. Hence, many governments (e.g. Switzerland, Colorado, and many more) passed laws that make the generation of hazard maps legally binding.

In Switzerland, hazard maps encompass rock fall, mass movements, snow avalanches, and flooding. Potential hazardous processes are assessed and assigned to hazard zones based on the frequency and the intensity of hazardous events. These zones encompass the following four levels:

- Red: Considerable danger
- Blue: Moderate danger
- Yellow: Low danger
- Yellow/White Hachure: Residual danger




*Hazard map and corresponding frequency-intensity diagram* (Kunz 2011)

# 1.4. Visualisation of Spatial Data

## Cartography and Visualisation

Cartography has gained a new importance in relation to the visualisation of geographic objects and phenomena. Visualisation has been influenced in a positive way by the recent progress of computers and GIS. As a consequence, domains like interactive maps, data analysis or decision support made a big step forward.
This learning unit will introduce you into the concept of visualisation (definition, examples, etc.). You do not need any prerequisites.

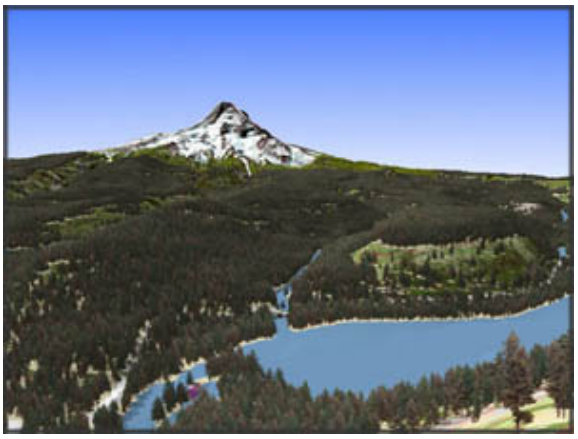
## 1.4.1. Visualisation

**What is Visualisation?**
Generally, scientific visualisation can be seen as a computer-assisted method, which can transform data and results of analyses into visual modes that could otherwise not be seen for instance due to their abstract nature. Thus, visualisation allows us to work very quickly and in an interactive way, with images and their underlying related data.

**Visualisation and Cartography**
In the context of cartography, concepts of modern scientific visualisation are only starting to be applied and even defined. 3D-visualisation with its continuous x, y and z data, however represents an indisputable advantage for cartography: **It reports a three or multi-dimensional reality, while the traditional paper map or screen is limited to "2D or pseudo 3D".**
But the complexity of such a multi-dimensional image implies that its application is reserved to a well-prepared public: however attractive the image can appear, its reading can be challenging.
On the other hand, the image and its elements should be designed in a user-friendly way in order to allow an easy and clear interpretation.

**Examples of Visualisation of Spatial Data**
The diploma thesis of M. Dobler at the Institute of Cartography ETH contains good examples of cartographic data visualisation. They have been realized using the software World Construction Set 4 and shows 3D-visualisations of the Mount Hood area in Oregon/USA.
Find a few visualisations, examples below. For more information click **here** (external link).

**Perspective View 1**
A perspective view of Laurance Lake and Mount Hood: Vector data of areas and line elements textured with effects: Trees, water, grass, snow.



*Laurance Lake and Mount Hood perspective view*

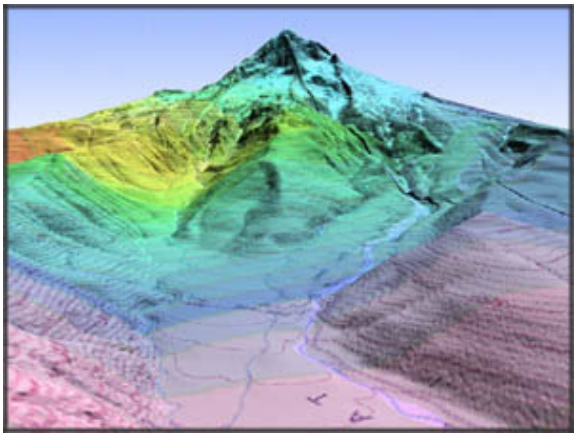
Raw Data used:

- USGS 7.5-minute DEMs, 1:24000, Digital Elevation Model, 10-Meter Resolution
- USGS 7.5-minute DRGs, 1:24000, Digital Raster Graphics, 4000x6000 Pixels, rgb Colors, 72 dpi
- USGS 7.5-minute DOQs, 1:24000, Digital Orthophoto Quads, 1250x1800 pixels, black & white, 72dpi
- Oregon Geospatial Data, 1:250000, Forest Lands, Derived from GAP Vegetation

More information about the data used, can be found at **USGS Geographic Data Download** (external link).

**Perspective View 2**

A perspective view of Old Maid Flat and Lost Creek: Digital Elevation Model, overlayed with a raster file of the annual precipitation combined with a topographic map.



*Old Maid Flat and Lost Creek perspective view*

Raw Data used:

- USGS 7.5-minute DEMs, 1:24000, Digital Elevation Model, 10-Meter Resolution
- USGS 7.5-minute DRGs, 1:24000, Digital Raster Graphics, 4000x6000 pixels, rgb Colors, 72 dpi
- Oregon Geospatial Data, 1:500000, Precipitation from USGS

Information about the Oregon Geospatial Data can be found at **Oregon Geospatial Database** (external link).

**Panorama Visualisation**

A panorama visualisation from Elk Mountain: Digital Elevation Model overlayed with a combination of the orthophoto and the topographic map. The panorama is made up of 16 images in steps of 22.5 degrees. It was created using "World Construction Set", stitched together with the software "VR Worx" and finally saved as a Quicktime movie. Click on the following picture and move the mouse into the direction you want.

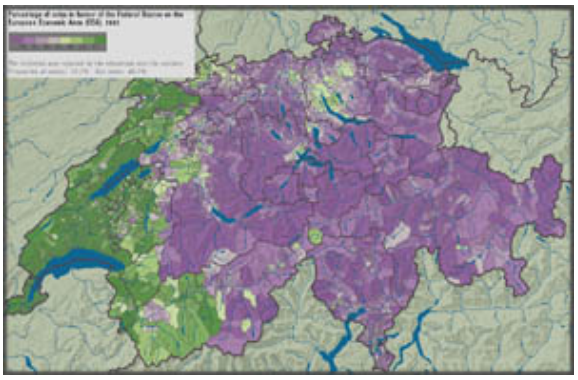
**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]**

Raw Data used:

- USGS 7.5-minute DEMs, 1:24000, Digital Elevation Model, 10-Meter Resolution
- USGS 7.5-minute DRGs, 1:24000, Digital Raster Graphics, 4000x6000 Pixels, rgb Colors, 72 dpi

- USGS 7.5-minute DOQs, 1:24000, Digital Orthophoto Quads, 1250x1800 pixels, black & white, 72 dpi

This last example shows a screenshot of a 2D visualisation of statistical data from the **Atlas of Switzerland interactive** (external link). The software allows interactive queries to be made within the map image.



*2D visualisation, Atlas of Switzerland 1* (Bundesamt für Landestopografie swisstopo (eds.) 2000)

Raw Data used:

- Digital Terrain Model of Switzerland DTM25
- Vector 25, vector 50 (digital landscape models derived from National map)
- Geostat: Spatial geographic- / statistical database
- Digital general maps of Switzerland

## 1.4.2. Summary

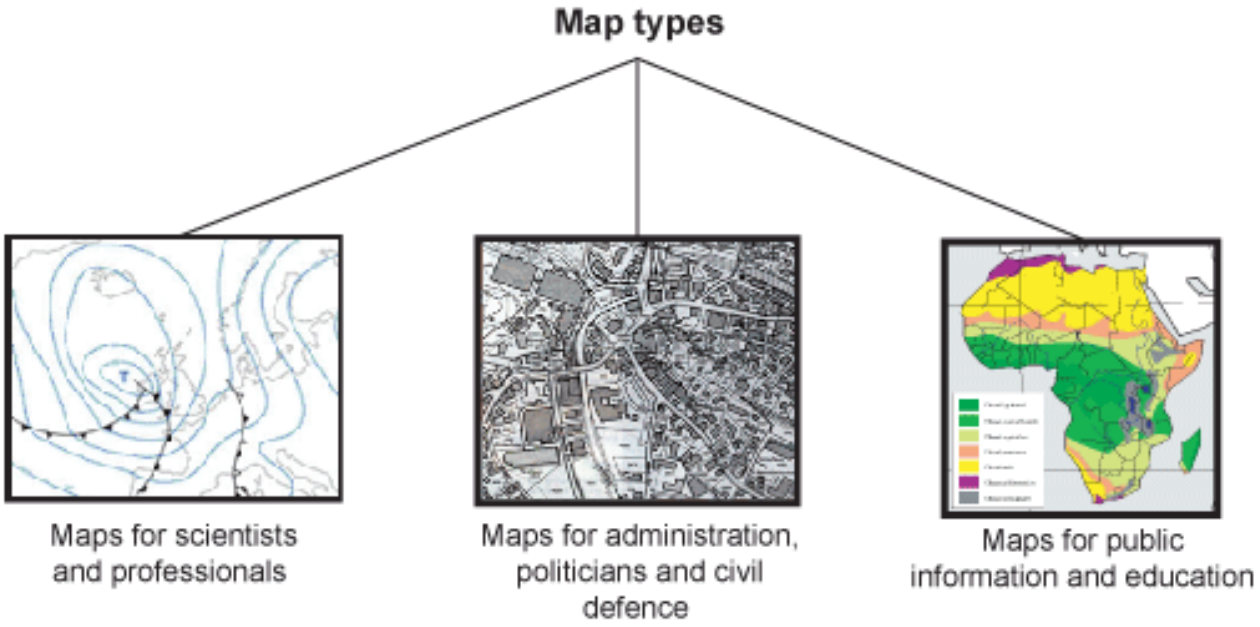
Virtually, everybody has the potential to create a cartographic visualisation of a spatial database by using special mapping, publishing and rendering software. As a result of this development, the task of map creation will increasingly be shifted from the professional cartographer to the map user itself.
However, this bears some danger, since the general user normally does not know about cartographic design and visualisation rules.
In conclusion, the visualisation is still an emergent discipline with remaining problems and with a lot of unanswered questions.

# 1.5. Map Types

## Who are the Users ?

Users are those persons who turn to a map for a particular reason. Each user, or user group, brings a particular set of experiences, and use maps in a different way. Many users are experienced in the use of the maps and know the possibilities and limitations of maps. Others are less informed about the nature of maps and do not have the knowledge to efficiently take advantage of the information inherent in the maps.
Therefore, it is very important for the map-designer to have a good knowledge of his potential map users. So, the primal objective of this lesson is to give an overview of the various map types and users' communities, and to describe the way they use them, so that the designer (you!!) can realise an ideal user-friendly map.
To simplify the wide range of map types, a classification in three main groups is made here:

- Maps for scientists and professionals
- Maps for administration, politicians, civil, and civil defence
- Maps for public information and education




*Map Types Example*

**Note**: It is not the objective of this course to draw up an exhaustive list of all the map users, but to describe the main user groups which, have a common "cartographic behaviour ".

## 1.5.1. Maps for Scientists and Professionals

Maps used by scientists and professionals serve mainly for localising information (as for example: meteorological maps). Therefore, basemaps should not be overloaded, but nevertheless, present all the information to support the map theme. These kind of maps are often defined and produced once, then used repeatedly. Maps for scientists and professionals cover the following domains: earth science (Geography,

Geology, Geomorphology, Geophysics), general space analysis, etc. But also bathymetric charting, soils and agriculture, space and astronomy, hazards mapping, insurance and risk management, business location and market analysis, etc.
In the following slide show, you can observe different maps for scientists and professionals.
Click on map to enlarge

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]**

## 1.5.2. Maps for Administration, Politicians and Civil Defence

Maps used by this user group often serve to administer the geographic space. Therefore, information should be targeted and clarified according to the aims (the basic information is often collected by surveyors and statisticians). Maps for administration, politicians, and civil defence can cover the following domains: planning, country and forestry, industry, water management, urban development, national defence and network traffic routes supply, energy industry.
In the following slide show, you can observe different maps for administration, politicians, and civil defence.
Click on map to enlarge

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]**

## 1.5.3. Maps for Public Information and Education

Maps used for public information and education are often simplified: the main information is exaggerated, and additional information is reduced. This allows a better understanding of the relevant facts, especially by persons who are not used to read maps. The objectives of maps for public information and education can be educational purposes (e.g. school atlas, geography books), explanation of current events (e.g. press maps), communication about geographic places, etc.
In the following slide show, you can observe different maps for public information and education.
Click on map to enlarge

**Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]**

## 1.5.4. Summary

Many maps are designed and produced to serve very specific goals according to the users needs. Other maps contain so much information that they are used by a variety of users for a great variety of tasks. Therefore, it is very important for the map designer to define the needs of the users in advance, in order to avoid disproportionated maps.

# 1.6. Map Critiques

**Objective**: Train your sensitivity to mapping.

**Task**

Find a map or a map related illustration in a newspaper, leaflet, book, internet, etc. Prepare a well-designed written discussion taking the following into account: Present your discussion in a written DIN A4 page layout together with digital version of your map example. The text should be clear, explicit and without spelling errors including the following information: Name, Date, Map reference/source as well as the time you required. Your course leader will decide about the language to use (German/French/Italian/English). The questions below can be considered as a thread for your discussion:

- What is the map purpose?
- What is the map's type (thematic map – pros and cons)?
- Which elements belong to the basemap?
- Who could be the map user – target group?
- What would you improve on this map: objectives, quality, design, map elements etc.?

Submit your results (mail or printed) depending on the deadline your course leader conveyed to you.

## 1.7. Summary

Throughout this first lesson, we saw that each map has a specific communication objective. Therefore, maps can be vastly different from each other because, they serve specific purposes and have particular applications.

# 1.8. Glossary

**cartography:**

Cartography is the art, science, and technology of making maps, together with their study as scientific documents and works of art. In this context, we may regard all types of maps including all plans, charts, and sections, three-dimensional models and globes representing the earth or any celestial body at any scale.

**map:**

A map is a symbolised image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance.

# 1.9. Bibliography


- **Bundesamt für Landestopografie swisstopo (eds.)** (2000). *Atlas of Switzerland interactive*. [CD-ROM]. First Edition.
- **Bundesamt für Landestopographie**, 2000. Landeskarte, 1:50'000. Wabern: Bundesamt für Landestopographie (www.swisstopo.ch).
- **Chrisp, P**, 1997. *Maping the Unknown*. Raintree Steck.Vaughn Publishers.
- **Dent, B. D.** , 1996. *Cartography - Thematic Map Design*. Forth Edition. WCB Wm c. Brown Publishers.
- **Engelberg-Titlis Tourismus AG**. Available from: http://www.engelberg.ch [Accessed 04-05-2016].
- **Institute of Cartography, ETH Zurich**. Available from: http://www.ikg.ethz.ch/ [Accessed 04-05-2016].
- **International Cartographic Association**, 1984. *Basic Cartography for Students and technicians, Vol. 1*. third edition.
- **International Cartographic Association**, 1996. *ICA News 26*. Abderdeen, UK.
- **International Cartographic Association**, 1973. *ICA News 13*. Abderdeen, UK.
- **Kunz, M.**, 2011. In: Kunz, M. and Hurni, L.: How to enhance cartographic visualizations of natural hazards assessment results. The Cartographic Journal, doi: 10.1179/1743277411Y.0000000001. Hazard data by courtesy of Kanton St.Gallen. Basemap reproduced with the authorization of swisstopo (JD100042).
- **Makower, J.** , 1992. *The Map Catalog: every kind of map and chart on earth and even some above it*. third edition. New York: Vintage Books.
- **Reinel, Pedro & Jorge**, 1519. South Atlantic Portuguese chart, Miller-Atlas.
- **ROBINSON, A. H. ;KIMERLING, A. J. ; MORRISON,J. L. ; GUPTILL,S. C. ; MUEHRCKE, P. C.** , 1995. *Elements of Cartography*. John Wiley & Sons, Inc..
- **Rusch, G.** , 1999. *Das Appenzellerland vergangener Zeiten*. Druckereu Appenzeller Volksfreund.
- **Southworth, M. & S.**, 1982. *A visual survey and design guide*. Boston: Little Brown.