<u>Thematic and complex Mapping</u>

If we rely on semantics, any map which has a theme is thematic. Such a broad view, however, leads us nowhere because there is no map which is without a theme. What we really mean by thematic map is a map which focuses on portraying certain specific information often at the cost of other information often more important but irrelevant to basic theme. The purpose of such a map is to meet the requirements of those and only those who are specialists and looking for theme specific information.

To make a distinction between thematic and general purpose maps clearer, let us look at a soil map of India drawn on a 1:1,000,000 map produced by the Survey of India. This map has all those topographical details, which can be incorporated in a map of that scale. If some features are not represented there, it is not because they were deliberately suppressed but because they cannot be represented at that scale of the map. These maps are made to cater to needs of specialist as well as common man. But the soil map is not a general map; it is made to serve the interests of a specific section of the society. It tends to give in permissible details everything about the distribution of various types of soils without caring much for the details printed on 1:1 million sheet of the Survey of India. Such a map is useful only to those who are interested in soils such as pedologists, land use planners and farmers. The soil map is a thematic map whereas the 1:1 million sheet of the Survey of India is a general purpose map.

There is another distinction that becomes obvious as soon as we see the two maps referred to above. The million sheets of the Survey of India are constructed on a much larger scale than the soil map of India. Most thematic maps are drawn on smaller scales but this should not be treated as a rule. In fact, many of the thematic maps of the National Atlas of India (English Edition) are drawn on 1: 1 m scale. But that must be the largest scale, possible for a country like India. Small countries with smaller territories can afford to make thematic maps on still larger scales. Nevertheless, most thematic maps are drawn on smaller scales. Sometimes, thematic maps are called statistical maps and vice versa. These two terms are not interchangeable, although most thematic maps do use data derived from statistical analysis of the raw data. There are two types of thematic maps:

Simple thematic maps are those which concentrate on the representation of a single feature; and 3, Complex thematic maps are those, which represent combinations, correlations, associations, variations or interconnections between several aspects of the same phenomenon or between two or more phenomena.

An example of the first type is the soil map giving the distribution of various types of soils in a given area. The example of the second type is a map showing the association or correlation between rainfall and rainfall variability.

Simple Thematic Maps Simple thematic maps can be classified into three types:

1. Qualitative in construction as well as in appearance.
2. Quantitative in construction but qualitative in appearance.
3. Quantitative in construction as well as in appearance.

Qualitative Thematic Maps

These maps show such natural and cultural features, whose distribution is usually Not measured quantitatively. Among such features are lithology, rock types, soils, Vegetation, religions, languages, etc. It is not to suggest that they are not quantifiable. It only means that the non-quantitative aspect of such phenomenon is often sought after and hence quantitative aspects do not get prominence.

One of the difficulties in constructing qualitative thematic maps is the problem of mixed or transitional areas. If we are showing religion-wise distribution of population in India, the Hindus are in majority in almost every administrative unit. How can we thow the distribution of minority groups like Christians, Muslims and Sikhs, unless We base our maps on certain quantitative values? There are, of course, methods to deal with such problems, but they give only a schematic picture.

Most of the qualitative maps use colour patch or choro-chromatic methods of representation. Colours are chosen carefully so that they are distinct from each other. Similar features have similar colours. For example, in a geologic map, all tertiary formations are shown in one colour. In a historical map, different kingdoms or countries are shown by different colours.

Qualitative thematic maps may also show the distribution of such features which do not distributed spatially. For example, a railway map uses line symbols to show raillway tracks. If these lines have different gauges or zones, each gauge or zone is shown by a different colour or a line symbol. At times a qualitative map gives only the location. For example, a mineral map may give the location or spread of mines of various energy and mineral resources without giving anything about their size or production. All such maps are thematic but non-quantitative. The reader should, therefore, be careful in not equating a thematic map with a statistical map. The two are not always the same.

Semi-quantitative Maps

Some cartographic techniques intermix qualitative and quantitative data. The most glaring example of this is the dot map showing the distribution of population or slope. In a dot map, each dot may represent a quantitative value but we rarely use it for quantitative interpretation. It gives only a, visual picture of population distribution; we never try to get the values represented by the dots by multiplying the number of dots by the values assigned to each dot. A dot map is different from a choropleth map. By looking into the legend of a choropleth map we can determine the density of the element represented, but a dot map does not help us to do that. Each dot stands individually and at least theoretically stands for the point at which it is placed. It represents no area and hence gives no quantitative measurement.

Quantitative Maps

Finally we come to the simple thematic maps of quantitative nature. Among such maps are the density maps which give the frequency of occurrence of a phenomenon by civic divisions such as Talukas, Districts or States. The simple way to prepare a distribution map is to colour or tint the civil divisions darker or lighter in proportion, to the density of distribution.

We can have choropleth or isopleth maps also to represent distribution. Such maps give the numerical values for different areas. We use isopleths for continuous area distribution and choropleth for discrete area distribution.

COMPLEX THEMATIC MAPS

When more than one set of equally important data are portrayed on a single map to show combination, correlation, association, or interaction, we get complex thematic maps. Almost all complex thematic maps can be called 'quantitative maps'. Such maps may show, for example, the rural and urban population by circle graphs. In a medical geography map of disease morbidity, death rate, number of hospital-beds and so on, can be shown on a single map to give a comparative picture. Most of these maps are analytical and give very specialized type of information.

Thematic Mapping involves a series of problems. Some of them are discussed below.

Choice of Map Projections

All map projections, as we have already noted, do not suit the requirements of all types of maps and data representation. Maps showing spatial distribution of a phenomenon must be drawn on equal area projection. But there is no equal are projection which shows every part of the world satisfactorily. On the margins the shapes are so distorted that the representation touches the stage of meaninglessness. With thé increasing tempo of international cooperation, necessity of thematic maps with common scale, projection and symbols has not only increased but also become indispensable. Further, the variety of thematic maps that we see today is so bewildering that limited number of simple projections that we have at our disposal will not suffice. In any case each thematic map being a unique piece in many respects, it needs a unique projection suited to it and, may be, it alone. We have, therefore, to devise new ways of deriving projections and to elaborate and develop further the already known projections to sult modern needs. Increasing use of computer in cartography helps in developing new and problem specific projections, but the possibilities of innovations are limited as there is no projection which can keep the measurements of the globe intact.

Waldo Tobler, in the USA has done considerable work in this field. He has not only given lead in the derivation of projections by feeding data in computers, but also in newer uses of projections. Projections, he says, are nothing but the means to transform a given surface into some other form. This concept, although inherent in map projection had not caught the attention of geographers. If transformation of a surface is the real purpose behind map projections, the conventions regarding the location of poles, equator and parallels and meridians have no meaning. The approach has opened up new avenues for research in this area.

Choice of Base Map

The success of a thematic map depends to a considerable extent on the quality of the base map. As the demand for thematic maps increases, the need for devising more efficient ways of preparing base maps increase. Even at present, thematic cartographers are handicapped by the non-standardized base maps available to them. Especially for the purposes of International Series of thematic maps, the quality and uniformity of base maps need further improvement.

Data and Their Representation

Whether simple or complex, a thematic map is designed to give limited information. It caters to the specialized needs of the people. The idea is to represent something which appears more prominently on the map than other things. For example, if the purpose is to show the distribution of cattle, nothing should appear on the map as prominently as the distribution of various species of cattle.

The question is: can a given phenomenon stand alone in a thematic map? How prominently should we show thing that are related to the main theme of the map. While showing the density of population, should we also show the physical built of the country, river courses, mountain chains, rainfall, etc. also? If we decide to do so, then the question arises as to whether we should have a single map or a series of maps. If we give the distribution of population by dot method and show the pertinent Physical features as background, we get a simple thematic map.

The population sheets Of the National Atlas of India fall in this category. But if we venture to show the telationship between, say, rainfall and density of population then we get a complex thematic map. In the latter case the objective is to show the relationship between two phenomena and not to represent the distribution of a single phenomenon.

If we are making a simple thematic map, we have to keep the less important but hot irrelevant data in the background. We know that the distribution of cattle will depend on a variety of factors: physical and cultural especially. Among the physical _ factors are the landforms, climate and vegetation. In a hot and wet climate cattle do not thrive well. In areas of scant vegetation and sparse settlement, one should not expect a dense cattle population. In many mountainous areas too cattle are not important. In arid areas, one finds sheep instead of cattle. How to show these facts on a map showing the distribution of cattle calls for the ingenuity and innovativeness of the cartographer.

If the purpose of the map is to show the distribution of cattle, no other data should be shown as prominently as this. We can show the landforms by light plastic shading, rivers in light blue and temperature by light colour isotherms so that a map reader interested in knowing the reasons why cattle population is thin or dense in certain areas, can speculate the possible reasons by seeing the background information.

Generalization of Data

Thematic mapping being essentially a small scale mapping, the problem of generalization is more pertinent to this aspect of cartography than to others. At present we have no standard method of generalization. In fact each cartographer uses his own intuitive judgment in this regard rendering the comparison of maps produced by different organizations difficult.

The problem of generalization acquires new complexities in case of thematic mapping, especially because thematic maps are drawn on different scales, and each scale can take only a limited amount of generalization. The time has, therefore, come to elaborate and further refine the theory of generalization so that the intuitive approach is replaced by 'standard measures'.

Standardization of Symbols

So long as each country considered itself to be an island for cartographic purposes, the problem of standardization of symbols did not arise. With increasing contacts among the nations of the world, many of the topographic symbols have acquired international standards. But not much has been done to standardize the symbols used in thematic mapping. For efficient estimation, comparison and wise use of our resources, it will help if thematic maps portraying a given information pertaining to different areas of the world use the same symbols. This is more so with respect to national maps. The International Geographical Union (IGU) has recommended a set of symbols to be used by all the member countries engaged in land use mapping. If land use maps of all countries of the world use these symbols, it will be possible for us to determine and compare the land resources of different parts of the world more precisely, Unfortunately not all the countries have accepted or implemented the recommendations of the IGU.

Compilation of Data

As the number of map users increase, and the opportunities to further refine and analyze map information improve, demand for more specialized maps will increase. The existing process of compilation is slow and cumbersome and more suited to the days when maps were used only by a privileged group. Methods which give quick and also cost effective results will have to be adopted. The mechanical process of compilation involving the use of computer and its accessories appears to show the direction in which cartographer should move for this purpose.

ATLAS MAPPING

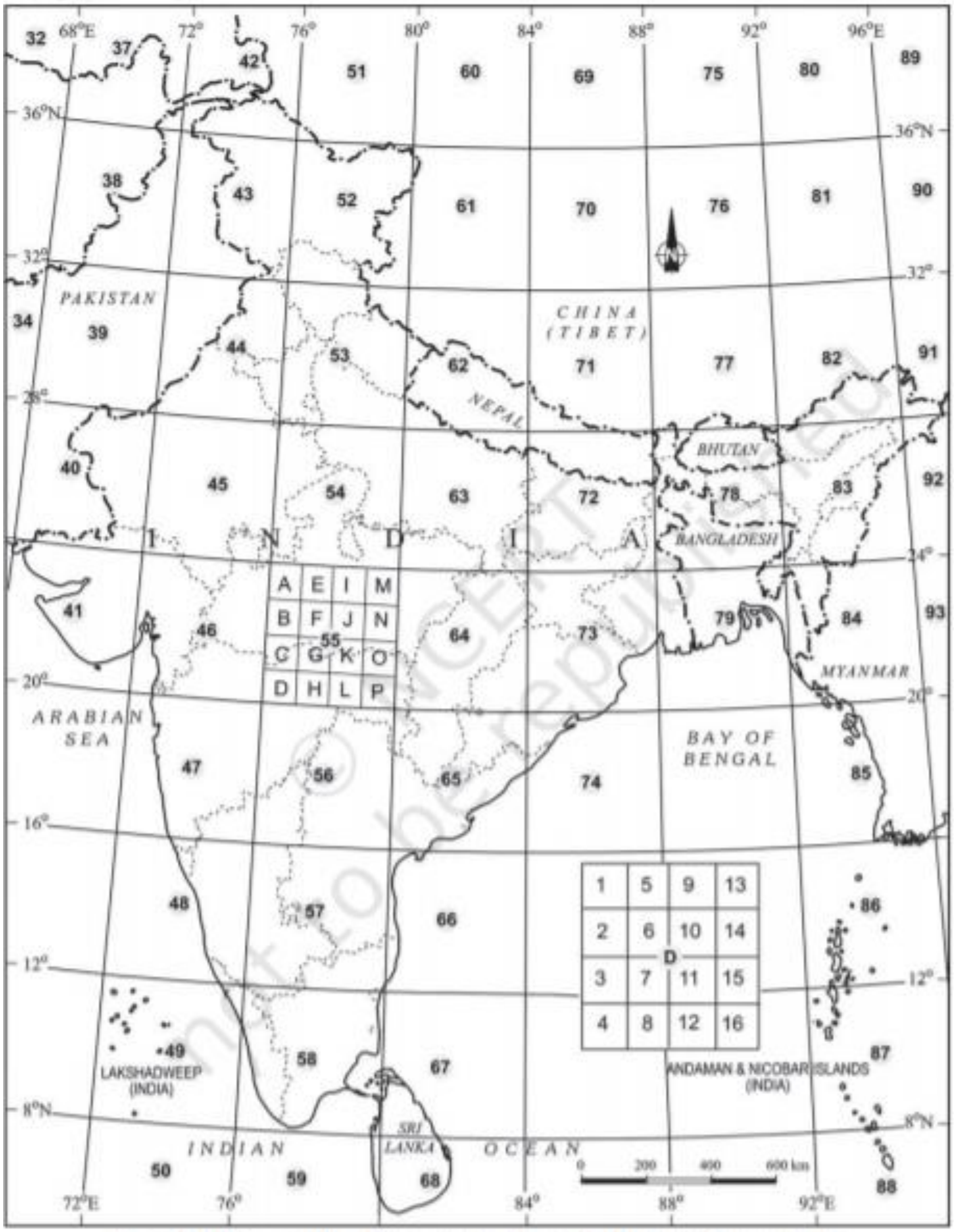
- An atlas is a collection of maps; it is typically a bundle of maps of Earth or a region of Earth.
- Atlas maps are very small-scale maps.
- These maps represent fairly large areas and present highly generalised picture of the physical or cultural features. Even so, an atlas map serves as a graphic encyclopaedia of the geographical information about the world, continents, countries or regions.
- When consulted properly, these maps provide a wealth of generalised information regarding location, relief, drainage, climate, vegetation, distribution of cities and towns, population, location of industries, transport-network system, tourism and heritage sites, etc.
- Atlases have traditionally been bound into book form, but today many atlases are in multimedia formats. In addition to presenting geographic features and political boundaries, many atlases often feature geopolitical, social, religious and economic statistics. They also have information about the map and places in it.
- https://en.wikipedia.org/wiki/Atlas

TOPOGRAPHICAL MAPPING

The topographical maps in India are prepared in two series, i.e. India and Adjacent Countries Series and The International Map Series of the World. India and Adjacent Countries Series: Topographical maps under India and Adjacent Countries Series were prepared by the Survey of India till the coming into existence of Delhi Survey Conference in 1937.

Henceforth, the preparation of maps for the adjoining countries was abandoned and the Survey of India confined itself to prepare and publish the topographical maps for India as per the specifications laid down for the International Map Series of the World. However, the Survey of India for the topographical maps under the new series retained the numbering system and the layout plan of the abandoned India and Adjacent Countries Series. The topographical maps of India are prepared on 1 : 10,00,000, 1 : 250,000, 1 : 1,25,000, 1 : 50,000 and 1: 25,000 scale providing a latitudinal and longitudinal coverage of 4° x 4°, 1° x 1°, 30' x 30', 15' x 15' and 5' x 7' 30", respectively.

International Map Series of the World: Topographical Maps under International Map Series of the World are designed to produce standardised maps for the entire World on a scale of 1: 10,00,000 and 1:250,000. Reading of Topographical Maps: The study of topographical maps is simple. It requires the reader to get acquainted with the legend, conventional sign and the colours shown on the sheets. The conventional sign and symbols depicted on the topographical sheets.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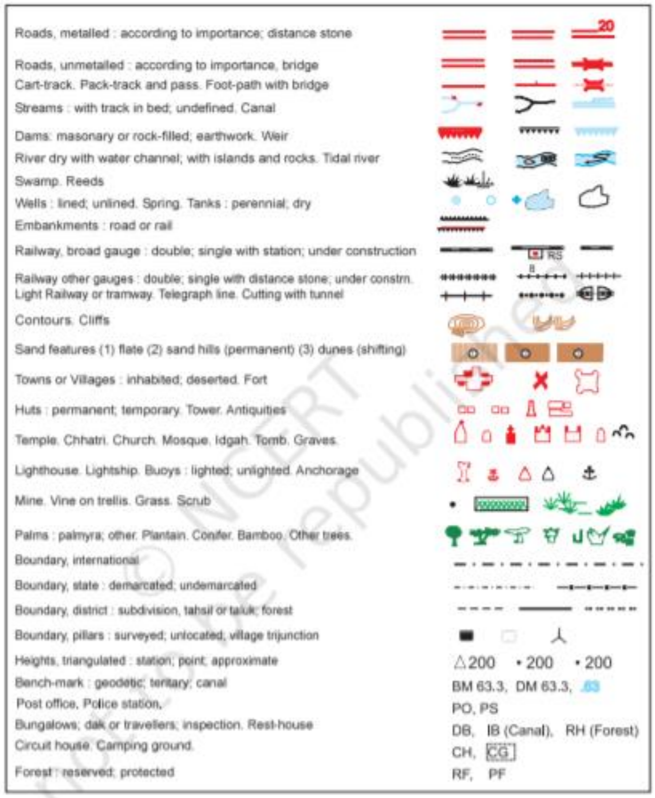


A number of methods have been used to show the relief features of the Earth's surface on maps, over the years. These methods include hachure, hill shading, layer tints, benchmarks and spot heights and contours. However, contours and spot heights are predominantly used to depict the relief of an area on all topographical maps.

NATMO (National Atlas and Thematic Mapping Organization)

- http://www.natmo.gov.in/
- National Atlas and Thematic Mapping Organization(NATMO) functioning as a subordinate department under the Department of Science & Technology, Ministry of Science & Technology, Government of India, with its headquarter at Kolkata.
- Since its inception, it is the sole national agency bearing the responsibility of depicting national framework data in the form of thematic maps and atlases to cater the various needs of different sectors.
- NATMO being a specialized institution of its kind also engaged cartographic and geographical researches at national level.
- NATMO has conceived and published more than eight hundred themes under the broad category of physical, social, economic, environmental disciplines. It has the largest repository of spatial and non-spatial data processed with greater accuracy for delivering

good quality products. To ensure precision and value addition, NATMO keeps pace with the most modern technologies viz. GIS , GPS and Remote sensing.

Main Functions of this organization are :

- Compilation of the National Atlas of India in Hindi, English and other regional languages .
- Preparation of thematic maps based on socio-economic, physical, cultural, environmental, demographic and other issues.
- Preparation of maps/atlases for visually impaired.
- Digital mapping and training using Remote sensing, GPS and GIS technology.
- Training
- Research & Development

SOI (Survey of India)

Survey of India, The National Survey and Mapping Organization of the country under the Department of Science & Technology, is the OLDEST SCIENTIFIC DEPARTMENT OF THE GOVT. OF INDIA. It was set up in 1767 and has evolved rich traditions over the years. In its assigned role as the nation's Principal Mapping Agency, Survey of India bears a special responsibility to ensure that the country's domain is explored and mapped suitably, provide base maps for expeditious and integrated development and ensure that all resources contribute with their full measure to the progress, prosperity and security of our country now and for generations to come.

The history of the Survey of India dates back to the 18th Century. Forerunners of army of the East India Company and Surveyors had an onerous task of exploring the unknown. Bit by bit the tapestry of Indian terrain was completed by the painstaking efforts of a distinguished line of Surveyors such as Mr. Lambton and Sir George Everest. It is a tribute to the foresight of such Surveyors that at the time of independence the country inherited a survey network built on scientific principles. The great Trigonometric series spanning the country from North to South East to West are some of the best geodetic control series available in the world. The scientific principles of surveying have since been augmented by the latest technology to meet the multidisciplinary requirement of data from planners and scientists.

Organized into only 5 Directorates in 1950, mainly to look after the mapping needs of Defense Forces in North West and North East, the Department has now grown into 22 Directorates spread in approx. all parts (states) of the country to provide the basic map coverage required for the development of the country. Its technology, latest in the world, has been oriented to meet the needs of defense forces, planners and scientists in the field of geo-sciences, land and resource management. Its expert advice is being utilized by various Ministries and undertakings of Govt. of India in many sensitive areas including settlement of International borders, State boundaries and in assisting planned development of hitherto under developed areas.

Faced with the requirement of digital topographical data, the department has created three Digital Centers during late eighties to generate Digital Topographical Data Base for the entire country for use in various planning processes and creation of geographic information system. Its specialized Directorates such as Geodetic and Research Branch, and Indian Institute of Surveying & Mapping (erstwhile Survey Training Institute) have been further strengthened to meet the growing requirement of user community. The department is also assisting in many scientific programs of the Nation related to the field of geo-physics, remote sensing and digital data transfers.

https://en.wikipedia.org/wiki/Survey_of_India

RECENT TRENDS IN CARTOGRAPHY

The application of scientific method into cartography made maps more ordered and accurate. Today, the art of map making is quite a sophisticated science employing methods from cartography, engineering, computer science, mathematics, and psychology.

Cartographers classify maps into two broad categories: reference maps and thematic maps. Reference maps normally show natural and human-made objects from the geographical environment with an emphasis on location. Examples of general reference maps include maps found in atlases and topographic maps. Thematic maps are used to display the geographical distribution of one phenomenon or the spatial associations that occur between a number of phenomena.

1. GIS and Digital Mapping
2. Mapping on the Internet and World-Wide Web
3. Computer Generalization of Spatial Data
4. Cartographic Theory and Methods
5. Map Design and Production
6. Spatial Data Visualization
7. National and Regional Atlases
8. Satellite Mapping
9. History of Cartography and Historic Maps
10. Cartography and the Environment
11. Education and Training in Cartography
12. Cartography and Children/Gender in Cartography

Modern Cartography Tools

Today's cartography tools have taken mapmaking to new heights, mostly in terms of detail and accuracy, but sometimes quite literally.

Mapmaking can employ a huge variety of methods and tools. Here we'll cover a few of the most common tools: aerial photography, sensors, GPS, satellites, and **GIS**.

Aerial Photography

Folks have been trying to get cameras into the sky for as long as those same cameras have existed. Early attempts at aerial photography included balloons, kites, and even rockets.

In 1860, the oldest surviving aerial photograph was taken by James Wallace Black, tethered in a hot air balloon 2,000ft above Boston.

Phantom 3 Drone

Modern aerial photography now relies on advanced technology like helicopters and unmanned aerial vehicles (UAVs) - more colloquially known as drones.

Able to reach impressive heights and controlled by hand-held remote, drones are are fantastic tool for aerial photography. Especially for **GIS mapping**, large-scale, consistent visual records make surveying and change detection a breeze.

Though drones are still fairly expensive, the barrier to entry is low enough that organizations and even most individuals can participate.

Sensors

Sensors detect events, changes, and physical characteristics of a given area by transforming stimuli (sound, light, heat, or motion) into electrical signals.

ZephIR 300M wind lidar device

Those signals are collected and then transmitted to another device, usually a computer. Put simply, sensors collect data about the Earth's surface.

Because sensors can detect and log huge quantities of accurate data regularly, they are often used in change detection projects. Essentially, creating one map of an area, waiting for a specified amount of time, creating another, and then comparing for discrepancies.

GPS

The Global Positioning System (GPS) is a **series of over 24 satellites** that orbit Earth regularly, each transmitting a unique signal.

Trimble Juno5 handheld GPS

GPS receivers intercept those signals and perform trilateration (distance based measurement between various points): enabling a highly accurate system of navigation.

Primarily used for navigation in aircrafts, cars, boats, and mobile phones, GPS is also the primary **tool for land surveying.**

Digital cartography has enabled the ubiquity of GPS systems. Users can employ GPS to track everyday trends like traffic, mark coordinates for landmarks, chart a path from one location to another, and find their own location within a map.

Satellites

Satellites serve a variety of purposes — from spying on foreign adversaries, to tracking weather and improving cell service, or as mentioned above - enabling the GPS network.

<u>Satellite</u>

In terms of **map making**, satellites enable consistent, large-scale updates of Earth's surface.

Think about modern applications like Google Earth or **cloud GIS tools**. These all rely on satellites for accurate **geospatial data**.

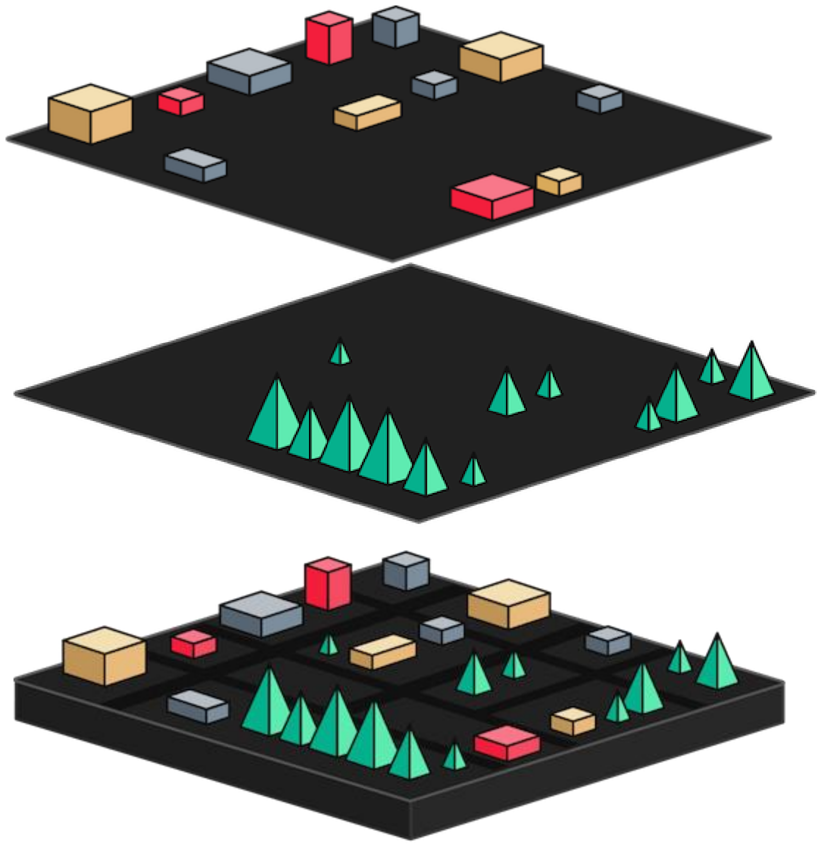
Satellites have increased the speed and range at which mappable information can be collected. Surveys that once took months can now be done in minutes.

By continually capturing footage of the Earth's surface, satellites have enabled the creation of thousands, if not millions, of maps - used in agriculture, **utilities**, forestry, earth sciences, global change, and regional planning.

Geogrpahic Information Systems (GIS)

Sensors, GPS, and satellites are methods through which to collect data.

These devices are quite advanced. However, as a general rule they lack the ability to display, organize, and manage the data they collect.



GIS provides the ideal solution.

GIS is location-based software used to view, organize, visualize, and analyze geospatial data. GIS helps users wrangle their data, enabling a better understanding of positionally based patterns and relationships.

Legacy GIS platforms, originating in the 1980's, provide tools for high-level scientific analysis and data visualization. These programs are most often desktop based and require local installation - though some do offer mobile applications.

In the last decade, **cloud GIS** systems have started to become more prevalent. Cloud GIS systems don't offer the same level of deep scientific analysis; however, they are significantly more mobile friendly - enabling users to **take GIS with them** wherever they go.

GIS mapping is a process that helps users manage, organize, and analyze location-based data.

Combining traditional mapping with location-based data, it was created in an effort to transcend the limits of two-dimensional paper maps.

Easily the most common use for GIS software, GIS mapping is used freqently throughout most built-world industries.

Mapping Basics: Thematic vs. Reference Maps

Legacy GIS Maps

a. Category maps

b. Quantity maps

c. Heat maps

Modern GIS Maps

a. Inspection maps

b. Hazard maps

c. Asset maps

Practical Applications of Modern Cartography

Most people interact with the products of modern cartography on a daily basis.

Consider the many apps in your phone. How many of them rely on location-based services? Navigation apps like Google Maps and Waze, ride services like Uber or Lyft, and food delivery apps like DoorDash all have some kind of mapping component.

That said, modern cartography goes far beyond simply finding your location on a map. Location intelligence, 3D modeling, and real-time map creation are all based in the application of modern cartographic tools.

Location Intelligence

Location intelligence

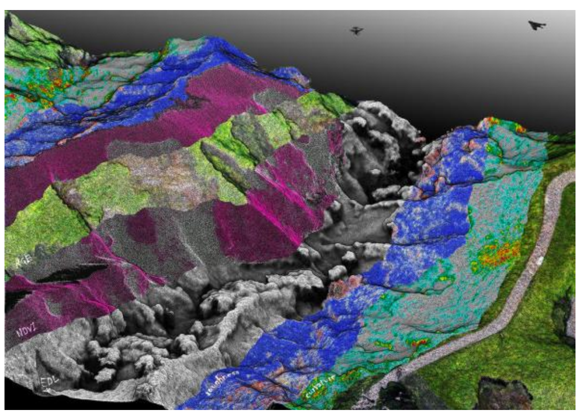
Location intelligence, also known as spatial intelligence, helps users derive insights and discover meaningful relationships within **geospatial data.**

Location intelligence emerged from the foundation of **GIS**, and is used to help organizations and corporations understand positional data.

Practical applications for location intelligence include risk assessment, delivery optimization, price configuration, and strategy development for acquisition or expansion.

3D Modeling

LiDAR, one of the modern cartography tools mentioned above, is integral to creating 3D maps and models. LiDAR relies on laser light to measure distance.



Point cloud of slope failures in Sensuikyo Valley

A laser pulse is released, travels outward, hits an object, and then bounces back. Similar to sonar, distance is measured by how long the pulses take to return.

Because light travels incredibly fast and in all directions simultaneously, LiDAR scans produce point clouds.

Consisting of millions of individual points, point clouds are basically highly-detailed 3D maps. The sheer number of data points means that LiDAR scans can create 3D maps of everything from a bustling metropolis to the Grand Canyon.

Real-time Map Making

Cloud technology has enabled mapping in real time. In contrast to locally installed software, **cloud-based GIS** platforms can be accessed via any web browser. This means any device connected to the internet can be used to view and interact with a given program.

Real-time digital mapping enables an incredible amount of activities - from tracking **utility inspections,** to watching as your Uber driver approaches the pick-up spot. Aside from the awesome number of applications, real-time mapping stands as perhaps the starkest indicator of how far cartography has come. From the earliest cave drawings to creating live maps to suit almost any purpose, the technological advances are truly astounding.

The short-term development trends of IT and mobile devices are more and more unpredictable. There are definitely trends, which look evident, which are easily predictable, but what is really difficult to predict are the user's behaviour and the prediction of which applications will be really wide-spread and popular. Just think about the heavily promoted functions and products of the last years (like MMS or 3D television), but the users finally did not like these products or the products were ahead of their time.

It is also possible to integrate GPS positioning into remote-sensing. Using DGPS or kinematic techniques, depending upon the accuracy required, real time or post-processing will provide positions for the sensor which can be projected to the ground, instead of having ground control projected to an image. GPS are becoming very effective tools for GIS data capture. The GIS user community benefits from the use of GPS for locational data capture in various GIS applications. The GPS can easily be linked to a laptop computer in the field, and, with appropriate software, users can also have all their data on a common base with every little distortion. Thus GPS can help in several aspects of construction of accurate and timely GIS databases.