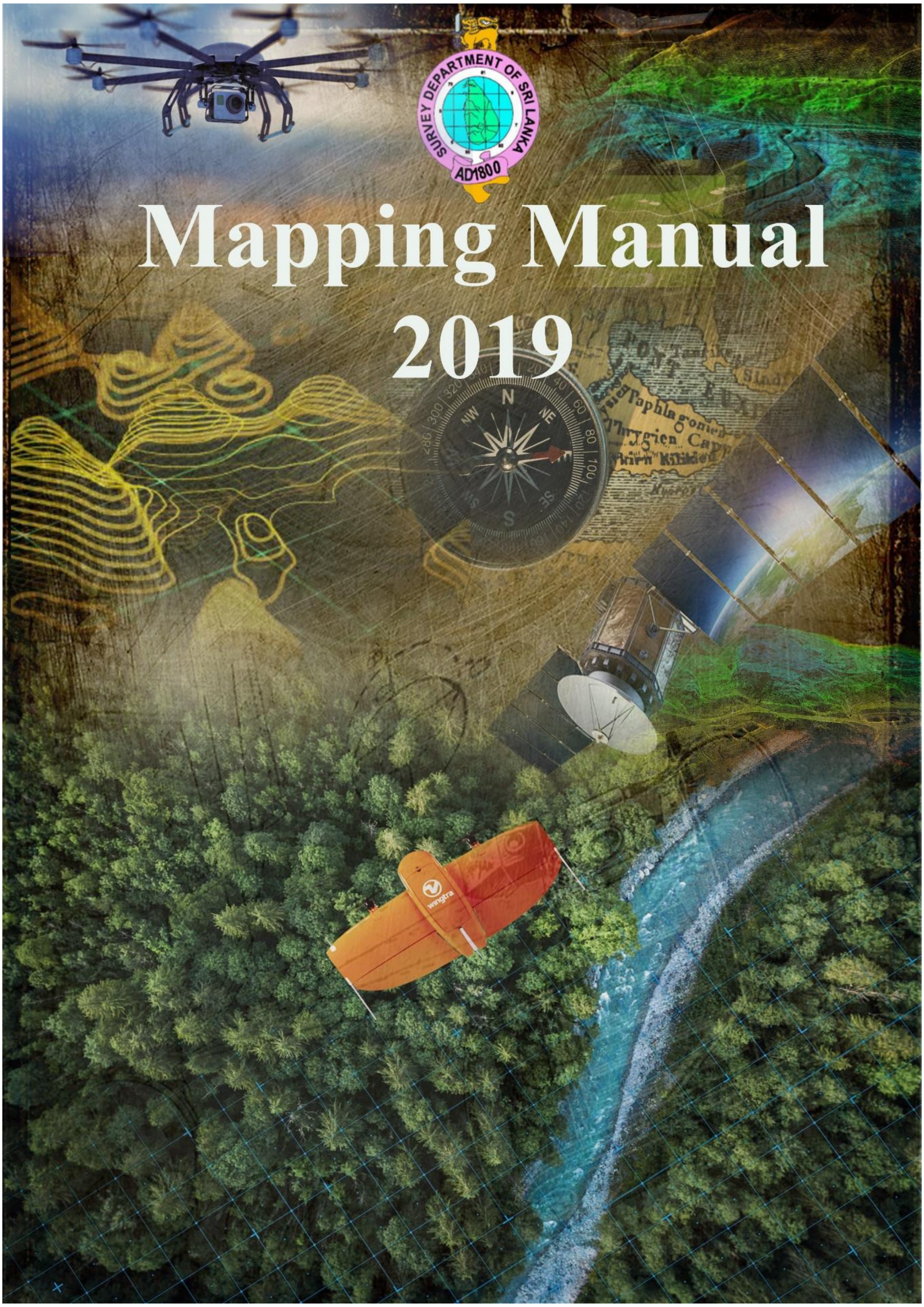
Mapping Manual 2019



Message from the Surveyor General

I am privileged to introduce the Mapping Manual which fulfils long term vacuum existed in s the map production line of the Survey Department. This exemplary text book is designed to cover up the documentation in mapping standards and correct technical map process. The Mapping Manual is a product of a dedicated and determined professionals committed to preparation of maps. The mapping manual will also function as the guideline for the Map Technological Officers to gather necessary qualification in their mapping career.

Since the mapping technologies are developing rapidly with the new technological innovations, I recommend that this mapping manual should be revised periodically in the future.

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Surveyor General
October 2019

Preface

The survey department has been actively engaged in national mapping throughout last two centuries. During this long period survey department has produced wide spectrum of map series such as topographical maps, provincial maps, tourist maps and thematic maps such as maps showing natural resources, precipitation, electoral districts and thematic maps for the national atlas. Map making process is being carried out through several production steps, starting from data collection, creation of database, generalization, cartographic enhancement, designing map layout, symbolization and finally map printing. Each production step is carried out by specific technical branch. Conventionally each technical branch is responsible for setting technical specifications and ensuring maintaining of technical standards of the map production component assigned to the branch. It was highlighted the lack of a published standard document covering entire scope of map production with essential technical specification. The "Mapping Manual" is prepared to fulfil requirement mentioned above.

Mapping Manual was designed to cover the history of map production, types of maps prepared by the survey department and technical standards to be maintained in order to prepare a qualitative map.

I would like to convey my gratefulness to the staff involved in preparation of this manual, especially the surveyor general for his continuous guidance, Senior DSG (Mapping and Geo-names), Senior Supdt. of Surveys (Mapping and Geo-names) and all other senior officers and the mapping staff who contributed generously for publishing this mapping manual in numerous ways.

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1.0 Introduction

Since the inception of the mapping process in the Survey Department there was no systematic manual prepared for mapping until 1980s. In 1979, Agricultural Base Mapping Project (ABMP) started to replace one inch topographical map sheets and to cover entire country in 1: 50,000 scale topographical maps. Sciambi (1979), senior technical advisor to ABMP project, had prepared a manual exclusively for ABMP mapping, widely known as Bruno's Report of which the title is *"BASIC CARTOGRAPHIC PRINCIPLES"*. A new project was commenced in 2010, to cover the Northern Province in 1:10,000 scale topographical mapping in collaboration with Japan International Cooperation Agency (JICA, 2012). Survey Department and JICA jointly prepared a report for 1:10,000 mapping for Northern Province mapping project. The final report of the project "The Digital Topographic Mapping Project for Reconstruction of Northern Region" was published in 2012. However, these two manuals were prepared to meet goals in two specific topographical mapping projects. In contrast the Survey Department had published plenty of diverse maps with the knowledge and the experience of the officers who had been engaged in mapping over the last two centuries. Most common among them was "One Inch" Topographical Series completed in 1925 covering entire country in 72 map tiles.

In order to specifically define the procedures and methodologies including cartographic enhancements of topographic maps, thematic maps and the customised maps produced by the Survey Department, Surveyor General of Sri Lanka Survey Department took an important decision to initiate a manual for mapping standards in 2017. Mandate for national mapping activities under the Sri Lanka by Survey Act No. 17 of 2002 is vested to the Surveyor General and his directive is to compile mapping manual to standardize content and the design of different types of maps including visual representation techniques of spatial features and their related attributes.

The mapping manual defines all steps beginning from map manufacturing process to the production of printed or digital maps, including the application of map generalization techniques and cartographic enhancement methods using a variety of symbols and abbreviations along with different map layouts.

These standards of representing features and information on maps are applied to all topographical thematic maps and Atlases which are published in the Survey Department. It should be mentioned that any new symbol/abbreviation created for a feature, which is supposed to be represented on a map on a request by any stakeholder or private party should be adopted only with the discretion of the Surveyor General.

1.1 Evolution of mapping

The earliest cartographic representation of Sri Lanka was Ptolemy's map of the Island published in 150 AD, where Sri Lanka was identified as Taprobana, was an island positioned close to the tip of the western coast of Southern India. Later, artistic maps of Sri Lanka (then called Ceylon) were drawn by the Dutch cartographers in the 17th and 18th century using more scientific cartographic techniques. Subsequently the British played an instrumental role in carrying out surveys and publishing series of maps in Sri Lanka in the 19th century.

The British published accurate maps of the island colony titled 'One inch to 4 miles map of Ceylon' for the first time in 1840. By 1897, the foundation for 'topographical mapping' was laid down after the Triangulation of Ceylon was completed. In 1924, a total of 72 maps, on a scale of 1 inch to 1 mile were released. These maps not only depicted relief features but also contained cultural features, geographical names, administrative boundaries, contours etc. The 72 maps required to cover the entire island were drawn on the basis of plane table surveys, which was a conventional ground survey technique. Within next 25 years, old methods gave way to new technologies after Sri Lanka gained independence from British in 1948. Aerial surveys carried to cover the entire island were conducted in 1956 on the scale of 1:40,000. The establishment of the Institute of Surveying and Mapping in the year 1969 paved the path to cover the formal training in mapping.

Figure 1.1 (a) Ptolemy's map, (b) A map made by Dutch

The first edition of maps drawn on a metric scale of 1:50,000 were completed between 1985 and 1996 with the help of extensive ground and aerial surveys. These maps were simply an updated version of the 1 inch to1 mile series, though on a metric scale. In 1988, the first National Atlas of Sri Lanka was published. By 1992, digital data compilation was introduced using photogrammetric techniques on aerial photographs. In 1983, a satellite image mosaic map of the country having a scale of 1:500,000 was published using LANDSAT 8 satellite images and it was further updated in 1992 using IRS 1B LISS II imagery acquired from the National Remote Sensing Agency, India.

2.0 Types of Maps

There are mainly two types of maps produced by the Survey Department; topographic maps and thematic maps. Topographic maps usually depict basic elements of spatial information such as land use, hydrographical features, transport features, contours, place names etc., and contains general information. Thematic map are based on a single topic such as geology, soil, population etc.

2.1 Topographic Maps (National Map Series)

A topographic map is a graphic representation to scale, showing horizontal and vertical topographic features of some portion of the earth's surface, systematically plotted on a plane surface.

A national map series is a group of topographic maps usually having the same scale and cartographic specifications, and with each sheet appropriately identified by its publisher.

Map series take place when an area is to be covered is considerably large to represent by a single map sheet due to its scale. In order to overcome this problem area is represented by systematic grid of interlased individual maps known as tiles. But each map sheet (Tile) can be used independently as a full pledge map.

2.1.1 One Inch to One Mile Map Series

The first complete topographical cover for the country was one inch to one mile map series endured over a long period from 1897 and completed in 1925. These map series was periodically revised until 1972.

Figure 2.1 (a) shows the sheet layout for the one-inch series and Figure 2.1(b) shows a part of one-inch map sheet.

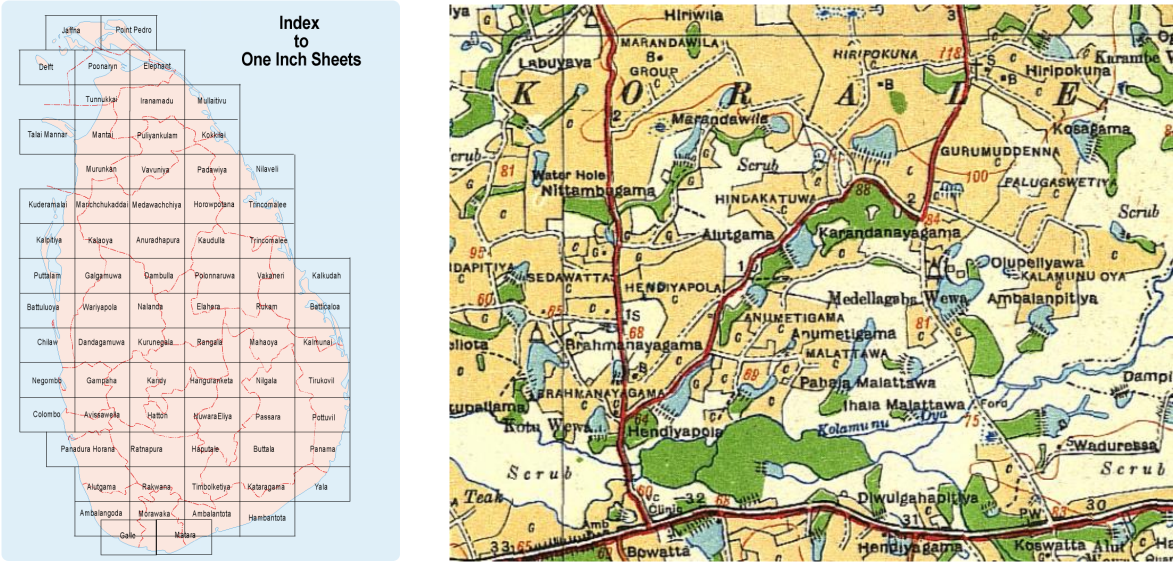


Figure 2. 1 (a) Sheet Layout of One Inch Series, (b) One Inch Map Sheet (Part of)

2.1.2 1:50,000 Topographical Map Series

In 1970 the Government of Sri Lanka decided to adopt the metric system (SI). This involved fundamental changes in the work of the Survey Department, with regard to surveying and mapping. It was decided to create a completely new map series of the country on a metric scale of 1:50,000 (with 20 meter contours), replacing One Inch series, in order to meet planning needs for the country's self-sufficiency in food. Each 1: 50, 000 map sheet of the new series was to cover an area of 40 km x 25 km covering 1000 km^2 in area with 20m contour interval. This series was published under the Agricultural Base Mapping Project (ABMP). Figure 2.2(a) shows the sheet layout for the 1:50,000 map series and Figure 2.2(b) shows a portion of a 1:50, 000 map sheet.

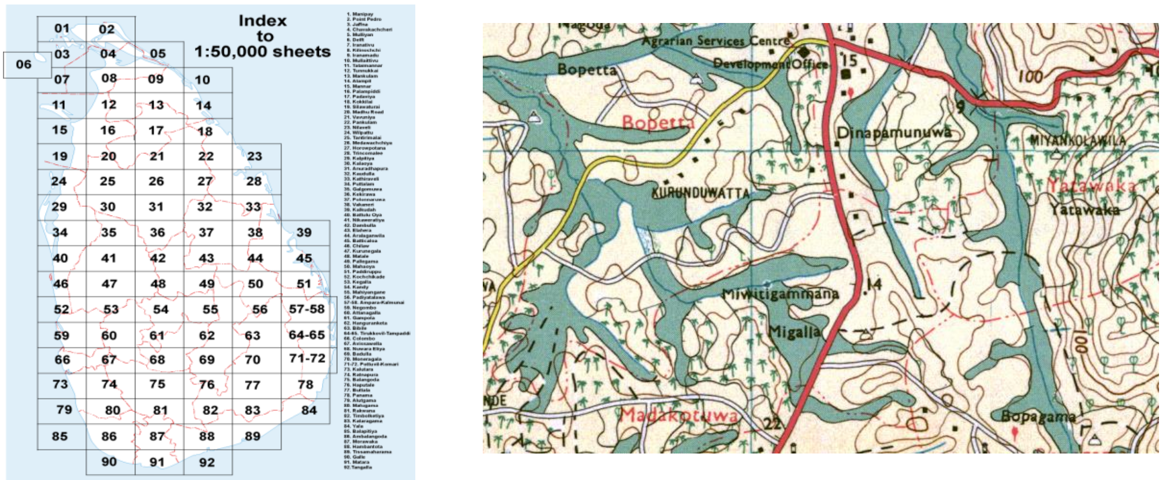


Figure 2. 2 (a) Sheet layout of 1:50,000 Topographic Sheets, (b) Part of 1:50,000 Map sheet

2.1.3 1:10,000 Topographical Map Series

The ABMP also envisaged the preparation of 1:10,000 maps. This was done by photogrammetric methods based on 1:20,000 aerial photographs and revised in field prior to final preparation for printing. There are 1834 sheets covering entire Sri Lanka. Each 1: 10, 000 map sheet of the new series was to cover an area of 8 km x 5 km covering 40 km^2 in area with 5/10m contour interval.

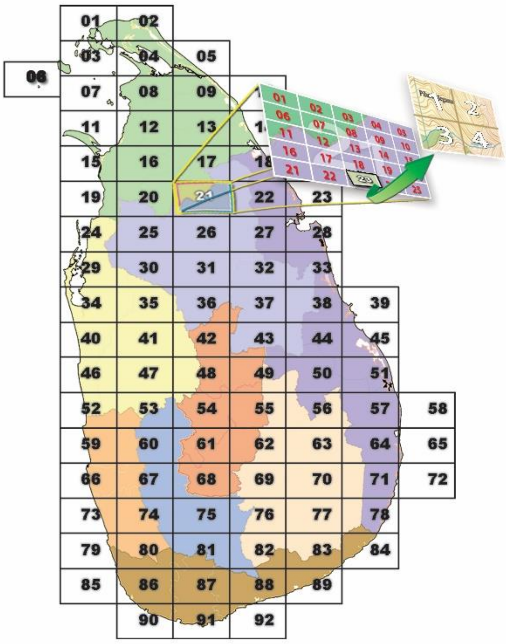


Figure 2. 3 Spatial layout of 1: 10k sheets on 1:50K

There are twenty five of 1: 10k topographical maps to cover one 1: 50k sheet as depicted in Figure 2.3. Each 1:10k sheet is divided to four sections as depicted in the figure to be used as key reference in all large scale statutory plans.

2.1.4 1: 250, 000 Topographic Map

This is a topographical map of Sri Lanka produced from 1:50k data applying map generalization techniques. The same layers depicted in 1: 50k represent on this map but subject to generalization of features to improve visual clarity. This is available in four sections.

2.2 Thematic Maps

The most common Thematic Maps are Road Map of Sri Lanka at the scale of 1: 500,000, A-Z Colombo at the scale of 1:10,000, Road and Town Atlas, Province Maps and District Maps at various scales. Some of the other important Thematic Maps are Tourist Map of Sri Lanka, World Map, School Map Series, etc.

Major publications of a series of Thematic Maps are; National Atlas of Sri Lanka and School Atlas available in book format. Both publications are available in tri-languages; Sinhala, Tamil and English, and have two editions with second edition being the latest.

2.2.1 Traveller's Map of Sri Lanka on the scale of 1:500,000

Traveller's Map, commonly known as Road Map at 1: 500k is prepared in colour with more details of information on the background page for easy reference of important details required for travellers. This map is created in all three languages and this is the most popular Thematic Map published by the Department. The focus on this map is to use for travelling purposes and it depicts most of the towns, transport network, major streams, and tanks/reservoirs in Sri Lanka.

2.2.2 Town Maps

Town maps are prepared for major towns based on data collected by large scale ground survey techniques. The scale of mapping ranged from one inch to 1, 8, 12 and 16 chains prior to metrication, and more recently from 1:10,000 to 12,500. A standard scale of 1:10,000 was used for all town maps prepared recently. All district capitals were covered in new Town map series, which was classified as 2nd edition of town maps. Further, there were some important towns considered for town mapping such as Katharagama, Dambulla, etc., and were prepared based on the 1:10,000 topographic data. Another important town map series was map of Colombo metropolitan area at the scale of 1:2000 prepared during 1999-2000. This map was compiled based on 1:8000 aerial photography.

2.2.3 Land Use Maps in Scale of 1:100,000

In 1982 the Department embarked on a programme for Land Use mapping at 1: 100,000 scale on district basis for the entire country using aerial photographs and satellite imagery. This programme was initiated in 1982 and data was mainly processed in the Remote Sensing Branch at Surveyor General's Office. This mapping mission was carried out under Sri Lanka/Swiss Remote Sensing Project, and completed in 1991.

2.2.4 District maps

All district maps are prepared at 1: 100,000 scale except in the districts of Colombo and Kalutara where maps are prepared at a little larger scale of 1: 75,000, considering the spatial congestion of features. Distract maps are focused on depicting the topography of the district with less details of building information. The data are extracted form 1: 50,000 topographic map series. If the details of a district do not fit on to the standard paper size, it is prepared in sections.

2.2.5 Province Maps

Province maps are created by amalgamating district maps to the scale of 1:100,000.

2.2.6 Thematic maps for National Parks

These maps are prepared showing the habitats of wild animals, their usual tracks in addition to non-motorable and motorable access roads within and around the parks. Some other information includes on these maps are forest boundaries and circuit bungalows.

2.3 Custom Tailored Maps

These maps are created based on the requests made by Government stakeholders, private sector organizations and general public for their various needs, which involve decision making based on the details depicted on these maps.

2.3.1 School Maps

These maps are created with 1km to 5km buffer zone marked around the school for assisting admission of children to schools, and the request should come from the Principal of the respective school.

2.3.2 Police Area Maps

These maps are created based on the request from the officer in charge of a particular police division. These maps show all the prominent details, including administrative boundaries, which are available in 1:10,000 topographical map series.

2.3.3 DS Division/GN Division Maps

These maps are created on the request from different agencies for various purposes especially for development activities and research for health issues of the area. Main base layer depicted on these maps is the Administrative boundaries.

2.3.4 Medical Officer of Health Area Maps

These maps are created on request made by Medical Officer of Health (MOH) to show a particular area of interest.

2.3.5 Other Custom Tailored Maps

On customer requests, any other type of map can be prepared at different resolutions and scales according to the accuracy of data that fit the purpose of the requirement. These maps are prepared at the special mapping unit at the Surveyor General’s Office.

3.0 Map Production Process

Generally, topographic data required for different kind of mapping are produced by geo-informatics and mapping branches of the Surveyor General's Office (SGO) with the assistance of the field staff. Field staff carries out ground control Surveys required for spatial data acquisition processes, collection of the data such as missing features, attribute data collection and field verification.

3.1 The first Ground Survey approach for National Mapping

The first national map series known as 'one inch maps' had been produced by using different ground survey techniques such as theodolite surveys, plane table surveys and spirit levelling and small scale tacheometry etc. Among these techniques, the small scale tacheometry had been widely used to collect data to produce these maps.

3.2 First photogrammetric approach (Stereo Photogrammetry) for National Mapping

Since 1956 base data for topographic mapping were mainly produced by the photogrammetric branch through stereo plotting. At the early part of this era, outcome of the stereo plotting was hard copy manuscripts. However, in the latter part of this era, digital vector data were extracted from analytical stereo plotting. Digital photogrammetric workstations became the stereo data modelling devise for producing vector data required for mapping after the analytical stereo plotting era. However, since 1990 data for smaller scale mapping such as 1:100,000 and 1:250,000 were produced by the Centre for Remote Sensing (CRS) branch through satellite image processing and interpretation followed by on screen digitizing.

3.3 Current Spatial data sources and acquisition methods for mapping

Feature data extraction is the main step of spatial data acquisition process in creation of topographic data sets required for mapping purposes. Currently there are different sources and data capturing methods used for collecting data for different kinds of mapping.

Following are the data sources used to extract topographic features for mapping:

- Stereo Aerial photographs.
- Point cloud by Light Detection and Ranging (LiDAR) surveys.
- Space borne images.
- Unmanned Aerial Vehicle (UAV) data.
- Ground survey data.

3.3.1 Stereo Aerial photos for stereo plotting

Stereo photographs are the widely used feature capturing source in mapping processes of the Survey Department since 1956. Stereo aerial photographs are captured by air surveys and are subject to stereo modelling in order to extract features accurately depending upon the scale of the aerial photographs. It is possible to achieve both horizontal and vertical accuracy even up to ±10 cm level using this technique.

3.3.2 Space Borne Images

3.3.2.1 Low resolution satellite images

Until year 2000, availability and access to high resolution satellite images were very limited but low resolution images were available. During this period such low resolution satellite images were used for small scale mapping at the scales of 1:100,000 and 250,000 land use mapping. Terrain features such as land use polygons and hydrographical features were identified and extracted followed by rather cumbersome image processing steps in this approach.

3.3.2.2 High resolution Satellite images

Recently high resolution satellite images are widely available for the extraction of topographic features required for different kinds of mapping processes at scales ranging from 1: 5K to 1: 50K. Even far better accuracy can be achieved through further image enhancements like ortho rectified images using three dimensional ground control data. In addition to mono images, there are stereo satellite images available, which are capable of generating stereoscopic view and can be used to extract features similar to stereo photogrammetry.

3.3.3 Point Cloud by LiDAR Surveys

This technique is also enabling to extract features to suit different types of mapping ranging from 1:2k to 1:10k scales. Major advantage of this method is to get the elevation data for producing contours and different formats of relief maps. Digital Elevation Models (DEM) required for 3D mapping can be produced from the massive point cloud captured using this method. This technology is capable of covering a very large area within a reasonable time period.

3.3.4 Unmanned Aerial Vehicle (UAV) data

This technique is capable of capturing feature data and elevation data for very large scale mapping such as 1: 1000 or even larger. Currently there is a high demand for topographic data collected from this method particularly for the applications like utility management and city planning.

3.3.5 Ground Survey Methods

There are still considerable amount of feature data to be captured trough ground surveys, which is not possible through non ground survey methods. Mainly hydrographical features (all kinds of points, lines and polygons) are required even at 50k resolution in many areas of the country. Features such as drainage lines, utility features etc., are required for large scale mapping. There are robust and rapid ground survey methods such as GNSS technology with Real Time measuring capabilities to collect any kind of such feature data.

3.4 Use of Topographic databases for Mapping

Geospatial data for 1:10k topographic mapping and various types of other mapping were obtained from Topographical database established and maintained since year 2000 in the GIS branch. Currently Topographic data for all kinds of mapping are used from the Topographic databases established in the GIS branch. There are three types of topographic databases established in Geo-informatics section at different resolutions 2k, 10k and 50k. Though the resolutions are well aligned with national mapping scales, 10k and 50k etc., the sole purpose is not only catering data for mapping but also for multipurpose uses. All kinds of topographic data including metadata stored in Topographic databases are subjected to well-defined standard specifications. Rather the topological consistency and other data quality characteristics are maintained for these data through semi-automated type tools and techniques developed, and the temporal data are also archived through spatial data base management procedures. Digital topographic data structures of the above databases are given in Appendix I.

3.5 Verification of Feature Data

Topographical feature data are extracted and stored in database to be verified in order to ascertain the fitness with ground truth. Various geographical phenomena have to be dealt with, in order to achieve a successful verification. Some important aspects are; Geometric accuracy, attribute accuracy, Thematic accuracy and the completeness.

There are some sources and ways that can be adopted to do the verification:

- Through field investigations and measurements.
- In-house verification using authorised and up to date formal documents like gazettes, survey plans and large scale geo data sets such as cadastral and LIS data.
- Web GIS services like Google Earth with robust viewing systems like Street view, Open Street Map, Bing Map etc.

- Through crowd sourcing.

The first method above is the most reliable and straightforward way to get required data for the verification process but cost and time involved is high compared to the other methods. Verification algorithms required to get the verification results to the required degree of confidence are not discussed here.

3.6 Coordinate Reference Systems Adopted in Mapping

Currently two coordinate reference systems are in use, namely; Kandawala Datum (Earth Petrolium Service Group (EPSG) id EPSG:5234) and SLD99 Datum. However, the SLD99 Datum is the latest reference system to be adopted to all surveying and mapping activities in the country. A tedious program was commenced in 1992 to upgrade the then reference coordinate system known as Kandawala Datum of Sri Lanka by Trilateration and Global Positioning Systems (GPS). Finally in 1999 the entire horizontal network was upgraded and the new reference control network on SLD99 datum (EPSG id EPSG:5235) was established. It consists 273 Control points in the following categories.

a. Base Station (ISMD) = 01

b. No of Principal (AA) GPS Stations = 10

c. No of Primary (A) GPS Stations = 194

d. No of Trigonometrical (TN, TO) Stations = 48

e. No of Fundamental Bench Marks (FBM) = 20

Parameters of SLD99 datum are as follows:

I. Reference Local Ellipsoid : Everest-1830

Semi Major axis : a = 6377276.3450m

Semi Minor axis : b = 6356075.4131m

II. Datum Transformation

a) Seven (7)-Paramerer Datum Transformation (from WGS84 to Reference Local Ellipsoid)

Transformation Method : Bursa Wolf

Translation ΔX : 0.2933 m

Translation ΔY : -766.9499 m

Translation ΔZ : -87.7131 m

Rotation about X axis : 0.1957040”

Rotation about Y axis : 1.6950677”

Rotation about Z axis : 3.4730161”

Scale factor: 1.0000000393

b) 3-Paramerer Datum Transformation (from WGS84 to Reference Local Ellipsoid)

Three (3) Parameter datum transformation.

Translation ΔX : 97.000 m

Translation ΔY : -787.000 m

Translation ΔZ : -86.0000 m

3.7 Map projection

A map projection is one of many methods used to represent the 3-dimensional surface of the earth on a 2-dimensional plane in cartography (mapmaking). This process is typically, but not necessarily, a mathematical procedure (some methods are graphically based).

3.7.1 Creation of Map Projection

The creation of a map projection involves three steps in which information is lost in each step:

1. Selection of a model to represent the shape of the earth. (choosing between a sphere or ellipsoid)
2. Transformation of geographic coordinates (longitude and latitude) to plane coordinates (Eastings and Northings).
3. Reduction of the scale (in manual cartography this step come second, in digital cartography it comes last)

3.7.2 Map Projection Categories

Projection classification is based on type of projection surface that is used. The projections are described in terms of placing a gigantic planar surface in contact with the earth, followed by an implied scaling operation. These surfaces are classified as cylindrical (ex. Mercator’s projection), conic (ex. Albers projection), azimuthal or plane (polar region projections).

There are several different types of projections that aim to accomplish different goals while sacrificing data in other areas through distortion. It is impossible to construct a map projection that is both equal area, azimuthal and conformal.

- Area preserving projection – equal area or equivalent projection

- Shape preserving – conformal, orthomorphic
- Direction preserving – conformal, orthomorphic, azimuthal (only from a the central point)
- Distance preserving – equidistant (shows the true distance between one or two points and every other point)

3.7.3 Orientation of the Projection

Once a choice is made on projection surface, the orientation for that surface must be chosen (how the cylinder or cone is “placed” on the earth). The orientation of the projection surface can be normal (in line with the earth’s axis), transverse (at right angles to the earth’s axis) or oblique (any angle in between). These surfaces may also be either tangent or secant to the sphere or ellipsoid (if you see both a 1st and 2nd parallel on a projected map then the projection must be secant).

3.7.4 Transverse Mercator’s Projection

Gerardus Mercator introduced the Transverse Mercator projection in 1772. It uses a horizontally oriented cylinder tangent to a Meridian. This is particular useful for mapping large areas that are mainly north-south in extent. This is the projection used for producing topographic maps of Sri Lanka. Standard map projection and the reference datum used in most of the maps n Sri Lanka is Transverse Mercator and Everest 1830 respectively.

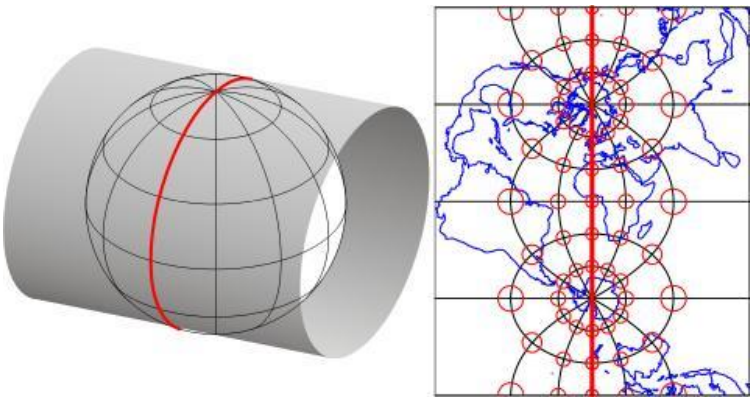


Figure 3.1 Represents a Transverse Mercator projection of the world with a standard meridian at 0° longitude. (Note that because of the very small size of the map, the graticule is shown at 30° resolution.)

As depicted in Figure 3.1 above, the globe wrapped in a cylinder is a conceptual model of how the Transverse Mercator projection formula transfers positions on the globe to positions on a plane. The cylinder can be flattened to a plane surface after it is unwrapped from the globe (figure 3.1 right). The thicker red line on the cylinder and the map is the standard meridian along which scale distortion is zero. As the error ellipses on the map indicate increase of distortion with distance from the standard meridian.

Map Projection Parameters

a) Transverse Mercator projection parameters
b) Map Projection : Transverse Mercator
c) Longitude of the Origin : 80º 46’ 18.16710” E
d) Latitude of the Origin : 07º 00’ 1.69750” N
e) Scale factor : 0.9999238418
f) False Northing : 500,000.00m
g) False Easting : 500,000.00m
h) Pidurutalagala Trigonomerical Station in old Triangulation Network has been used as the origin of the projection as used in the old system. This projected coordinate system is defined as National Coordinate System (National Grid System).

3.8 Map Generalization

Map generalization is the process of applying modifications to information on a cartographic map in such a way that information can be shown on a smaller surface retaining the essence of original geometrical and descriptive characteristics. This emphasises based on the fact that the smaller the map scale, the more of the representation is to be simplified and abstracted in order to maintain visual clarity and balance of the representation.

3.8.1 Generalization processes

Three distinct generalization processes can be identified from data collection to final map making. These processes are; object generalization, database generalization and cartographic generalization.

3.8.1.1 Object generalization

This process describes method of mental generalization in the sense of abstraction and selection from the real world data by the data collecting person (land surveyor, aerial photo analyst or GIS data analyst).

3.8.1.2 Database generalization

This process can be seen as a pre-processing step prior to visualization through cartographic generalization. This is also called statistical generalization because it is mainly a filtering process after object generalization, aiming at data reduction under a certain statistical control to maintain quality of information as much as possible with generalization operators such as **selection**, **removal, aggregation, typification** and **reclassification** operations with more or less no conflicts between objects. It also causes fewer generalization effects in which reduction of data volume is maximized while at the same time, modification of data is minimized. Further, it aims at minimum average displacement of objects. As a result, statistical generalization mainly affects the symbology of the map, which creates minimum conflicts.

3.8.1.3 Cartographic generalization

Cartographic generalization aims to modify the local structure of data. In this process the main aim is to give a better visual effectiveness to the graphic display with the best use of map space to optimize legibility at a given scale for a particular purpose of the map. This would more often cause graphical conflicts to be resolved after generalization using operations such as **symbolization**, **enlargement**, **simplification**, **displacement** and **exaggeration**.

3.8.2 Generalization approaches

Two approaches are identified in performing automatic generalization. They are; ladder approach and star approach, which are often adopted by National Mapping Agencies (NMAs), sometimes with a mixed approach of both methods. In the ladder approach, each small scale dataset is derived from a large scale dataset in steps. In Star approach all smaller datasets are derived from the one large scale base data set using generalisation. In some applications both ladder and star approaches are used known as mixed approach. Deciding which approach is chosen is important depending on the application requirement. In the application of deriving several small scale datasets using model generalization, adapting the ladder approach is not suitable since it degrades spatial accuracy up the ladder.

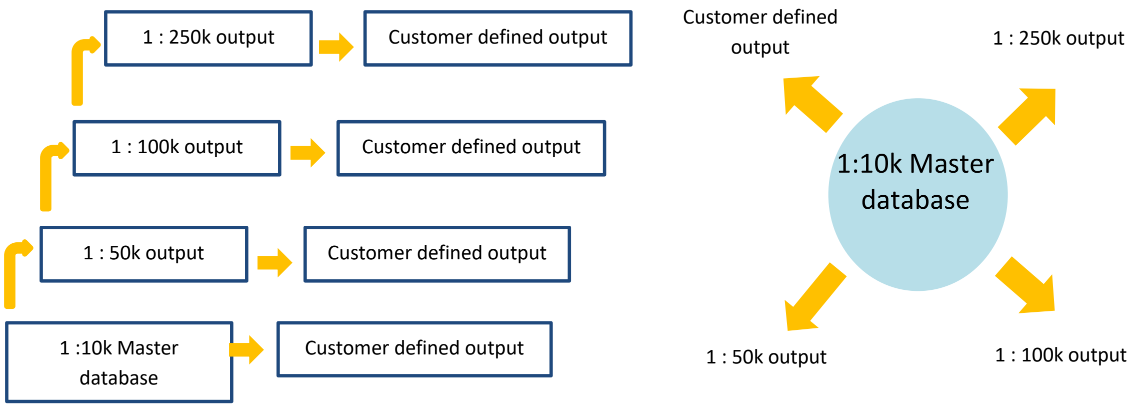


Figure 3. 2 Ladder approach (left) and Star approach (right)

4.0 Key Components of Maps

4.1 Map Details

Map details represent ground features as they existed at the date of map compilation or latest revision. Since human beings are continually building, demolishing, and changing ground features, the details appearing on a map may not exactly match what is appearing on the ground. This is especially true in developed areas. The amount of details shown on a map increased with its scale. A map attempts to show the maximum of details without impairing legibility. In areas of heavy cultural density, many of the less important items must be omitted. In areas of sparse density, fewer items are omitted. When deletions are necessary because of the density of detail, care is taken to retain the general pattern of the features in the area. For example, where all buildings of a group cannot be shown, those retained portray the general pattern of the group without exaggerating the area covered. Similarly, where numerous ditches, streams, levees, and the like exist, the less important are omitted and the more important are retained to show the characteristic pattern of the features in the area.

4.2 Scales

Standard scales of the Topographic maps in the Survey Department of Sri Lanka are 1 : 50,000 and 1 : 10,000. There are 92 tiles (actually there are 89 map sheets) in 1: 50,000 and 1834 tiles in 1: 10,000 scales to cover the entire country (see Figure 2.3 in Section 2 above for the tile arrangement of 1: 50k).

4.3 Symbols used for 50k Topographic Maps

So far as is practice, a mapped feature is shown by the same symbol on maps of different scales, but certain modifications and departures are necessary because of varying map uses and scales. Normally, symbols resemble the features they represent. The center and the orientation of a symbol usually correspond to the true center and orientation of the feature represented. All line features such as roads, railroads, streams, power lines, and similar features retain, within the limitation of scale, the variations of alignment which actually exist. Along such linear features as roads, the locations of close by buildings and other features are necessarily displaced because of the exaggerated size of the symbols. Reference to the positions of such features must be made with caution.

4.3.1 Roads, Railways and related Data

Consistent with map legibility and the density of cultural (man-made) development, topographic maps require maximum portrayal of road and railway features.

To assure map readability, symbol sizes are sometimes larger than actual map scale size. The symbols, therefore, are always plotted to that their centers coincide with the true position centers of the represented features; deviations from this requirement are permissible where displacement is unavoidably necessary due to close proximity of other plotted features. In such cases displacement is held to the absolute minimum consistent with map legibility.

4.3.1.1 Expressway

Expressways are specially designed for high speed travelling for limited type of vehicles. The national highways should be designed especially for high speed movement of vehicular traffic with minimum interference to such high speed traffic movements. National highways should not provide access to the properties bordering it. These roads consist of two or more lanes on each side of a physical separation such as a parkway.

4.3.1.2 National Highways

National Highways are the road or public road cross at least one provincial boundary and connects two or more provincial centres and is a principal thoroughfare for long distance of vehicular traffic. The road or public road connects two trunk roads or passes through important town centres on which the volume of vehicular traffic is more than two hundred and fifty vehicles per day.

National Highways are paved or metaled roads and carry either an “A” or “B” route designation. These are generally hard surface, all weather roads.

4.3.1.3 Secondary Roads

Secondary Roads are paved or metal led roads generally maintained by Provincial Councils or Local Government Authorities.

4.3.1.4 Tracks

Tracks and lanes are travel ways over a natural roadbed, with little or no improvements. These roads are capable of accommodating ox-carts or four wheeled drive vehicles only. Usually, these roads are not maintained. In some areas a distinction between motorable and non-motorable tracks may be required. The distinction is indicated by appropriate labelling. Examples: “Not motorable”, Motorable in dry season only”, “Inundated during rainy season”.

4.3.1.5 Footpaths

Footpaths are natural travelling ways which are not wide enough to accommodate four-wheeled vehicles. These roads are not maintained.

4.3.1.6 Railways

Railway tracks are perhaps the most accurately laid out man-made structure. This is so because the wheels of a train engine are fixed, they cannot be steered. The turning of a locomotive engine is accomplished by virtue of the arc of the track and the play (slack) between the wheel flanges and the rails. Therefore, all railway curves are smooth, flat arcs. The transition from a straight-away to a curve is gradual; there are no sharp corners. This is true even in a siding or railway yard. Extreme care should be exercised in selecting the proper curves so that the point of tangency blends smoothly into the arc, without a reverse curve.

Railway are classified and symbolized according to status (operating or non-operating); and by number of tracks.

(i) An operating railway is one that is at least in limited use over a maintained, permanent right-of-way.

(ii) A non-operating railway is one that is not in use and is not maintained. To be labelled as "non-operating" along the railway.

(iii) An abandoned railway is one that is not in use and the right-of-way is not maintained. However, the roadbed, tracks and bridges are largely intact and the line can be made operational with a minimum amount of repair. To be labelled “abandoned” along the railway.

(iv) A destroyed railway is one where the roadbed, tracks, or bridges are at least partially destroyed and which would require more than minor repairs to be made operational.

4.3.2 Hydrographical Features

A hydrographical feature is related to **characteristics** such as flow or depth of bodies of water. The depth and water flow and its spatial formation can be depicted on a map along with other topographic features. Vide Appendix II for Hydrographic Symbols used on maps by the Survey Department.

4.3.2.1 Streams and Related Features

The term “streams” includes rivers (Gangas, Oyas), creeks (cells), brooks, runs (ebas), etc. Streams are delineated in an amount sufficient to serve as the frame work for the hypsographic portrayal ; provide immediate recognition of land forms and direction of slope ; and reflect the existing type of drainage pattern. Short branches of streams may be omitted.

(a) A perennial double line stream measures 1 mm or more in width (map scale) at the normal stage of water.

(b) A perennial single line stream is as defined above, except that it measures less than 1mm in width.

(c) A braided stream is a water course which is not filled by the normal flow of water, and which sub-divides into an interlaced pattern of channels through the river bed.

(d) A meandering stream is a stream which follows a winding course through level land. Due to the natural run off of water, the alignment of the stream and the location of islands and sandbars therein are subject to change. The shoreline is delineated at the normal stage of water. Sandbars which fall below this stage of water are not shown.

(e) A single line intermittent or dry stream is delineated as such if its outer limits are less than 2 mm in width.

(f) A double line intermittent stream is delineated as such if its outer limits are greater than 2 mm in width. Permanent channels within the wash area shown as perennial or intermittent as appropriate.

(i) A disappearing stream is a water course which flows into a sinkhole and continues its course in a subterranean channel. The point of disappearance is shown ; the underground channel is not shown.

(j) Falls are created by a vertical or near vertical descent of the stream. This feature is sometimes called *a cataract or cascade. On double line rivers, the shape is indicated.*

4.3.2.2 Drainage (Inland Hydrography)

The term “drainage” includes those inland features, natural or man-made, of which water is a constituent part. The amount of water may be considerable, as in rivers, lakes, canals; it may be moderate as in marshes and in intermittent streams and lakes; or the degree of wetness may be a temporary condition as in washes and areas subject to inundation.

Drainage features are therefore categorized as perennial, intermittent and dry. As a general rule a feature is considered perennial if it contains water for an average of six or more months of the year; it is considered intermittent if it contain water for an average of less than six months; and it is considered dry if it seldom contain water, or contains water only during very short periods.

Drainage is important feature that can be shown on Topographical map. The drainage pattern, therefore, must be as complete and reliable.

In predominantly wet or well watered region, however, short tributary streams (less than 20 mm) ; small ponds (less than 1 mm wide); and features of small areal extent, such as marsh and paddies (less than 5 mm x 5 mm) may be omitted, especially if they tend to impair the legibility of the more important features.

In arid and moderately watered areas, the presence of water becomes even more important and short tributary streams and small ponds should be shown, although features of small areal extent may still be omitted.

4.3.2.3 Shorelines

In tidal waters, the shoreline delineates the limits of land features at mean high water level. Tidal waters implies anybody of water which is subject to periodic rising and falling, or flowing and ebbing, of the surface of an ocean ; i.e. , gulfs, bays, rivers, etc. , which are subject to such fluctuations.
In non-tidal waters, the shoreline is the line of contact with the land at a water level which prevails during six or more months of the year. This line is the "normal stage of water".
Shorelines for islands are delineated at the same hydrographical datum used for the shoreline of the adjacent mainland. That is either normal stage of water or mean high water. Features which uncover at a stage of water lower than the datum used for the mainland shoreline are not shown as islands. In the case of tidal waters these are shown as foreshore features.
A distinction is made between natural and man-made shorelines.

(a) The natural shoreline is not broken for single piers, break-water, isolated ferry slips of short sea walls and revetments.
(b) The natural shoreline is omitted for extensive water fronts, wharves, long sea walls and long revetments, except that an overlap of 2 mm is shown at the limits of the man-made feature.
(c) A definite shoreline is one whose position and shape have been accurately determined.
(d) An indefinite or un-surveyed shoreline is one whose position and shape are subject to change or have not been accurately determined. A shoreline being altered by dredging or filling is delineated as a natural shoreline and not as a man-made.

A pinpoint island is a small island whose shoreline would tend to coalesce at the publication scale. These are therefore shown as solids; their shapes being retained whenever possible.

4.3.2.4 Lakes, Ponds and similar features

Lakes, ponds and similar features are categorized as perennial, intermittent or dry. To be labelled as,

a. The shoreline of a perennial, lake or pond may be definite or indefinite and corresponds to the prevailing water level (normal stage).

b. The shoreline of an intermittent lake or pond corresponds to the outer limits of the feature (often the line of permanent vegetation), and is delineated with the indefinite symbol. A portion of a large intermittent lake which always contains water is delineated as a perennial feature; i.e., the actual condition is represented by a perennial lake within the intermittent lake. An island occurring within an intermittent lake is delineated with the indefinite shoreline.

c. The shoreline of a dry (or cyclical) lake or pond is delineated by the indefinite shoreline and corresponds to the outer limits. Included in this category are salt or alkali flats.

d. A salt lake is a perennial or intermittent body of brackish water. It is symbolized as any other lake, except that it is labelled “salt”. If the lake is named, the label is enclosed in parenthesis and shown immediately after or below the name. If the term “salt” is part of the name no additional labelling is required.

e. A tank or reservoir with a natural shoreline is an artificial lake formed by the water impounded by the bund or dam; it is always categorized as a perennial feature with a definite or indefinite shoreline representing the normal stage of water as controlled by the bund or dam. In compilation, the shoreline is omitted where it coincides with the bund or dam.

f. Abandoned tanks will be shown as perennial, with a definite or indefinite shoreline and will be so labelled in compilation stage. In the reproduction stage, these will be shown with and open-water fill band around the perimeter of the tank. Since the Government of Sri Lanka has repeatedly indicated its desire to rehabilitate most of the abandoned tanks, this symbol will facilitate the revision and updating of the maps as the tanks are rehabilitated.

4.3.2.5 Drainage and Irrigation Ditches (Channels)

a. A perennial double line ditch is a man-made excavation or trench, 1 mm or more in width, which is used for the control and movement of water.

b. A perennial single line ditch is defined as above, except that the feature is less than 1 mm wide. Ditches and to drain swamps (marsh) and areas subject to inundation are always delineated as perennial.

c. An intermittent ditch is also a man-made excavation or trench and is delineated as a single line regardless of width.

4.3.2.6 Water Conduits

a. A water conduit is an artificial or natural channel which carries water for either supply or industrial purposes. Included in this category are aqueducts, flumes, penstocks, pipelines and similar features; they may occur at ground level, or underground, or they may be elevated.
b. An aqueduct is an open or covered channel which carries large quantities of water. It may be constructed of brick, stone or concrete, or tunnelled through rock.
c. A penstock is a closed pipe or channel used by hydroelectric installations to carry water, under pressure, to the generating plant.
b. For ground level water conduits, the distinction between aqueducts, pipelines and penstocks is indicated by appropriate labelling.
c. For elevated water conduits, the term “Elevated” is added at appropriate intervals, as “Elevated aqueduct”, when the feature extends for a long distance.
d. For underground water conduits, the main lines are shown; short feeder lines to houses or villages are omitted. If another surface feature (such as a road or trail, a prominent fence, etc.) is located over the underground feature, the conduit symbol is omitted but the presence of the underground feature is indicated by labelling added to the surface feature; e.g. “Underground aqueduct”.

4.3.2.7 Miscellaneous Drainage Features

a. Salt evaporators (salt pans) are shown by delineating the outline and major separations. The feature is appropriately labelled.

b. Fish ponds and hatcheries are shown when large enough to plot to scale. The criterion for showing separations is the same as stated for salt evaporators.

c. Sewage disposal and filtration beds are show when large enough to plot to scale. The criterion for showing separations is the same as stated for salt evaporators.

d. Swimming pools and man-made reservoirs are shown when large enough to plot to scale.

e. A well is a pit or hole which is sunk, by digging or drilling, below the ground level to reach a supply of water. Unless available information in contrary, all wells will be shown as perennial. When practicable the name of the well is shown. Additionally, labels indicating the characteristic of the well are shown if known, such as; alkaline, mineral, un-potable etc. Walled-in springs, geysers, artesian wells and fountains are shown as wells and are appropriately labelled.

f. A cistern is a tank or similar artificial enclosure which is used for the collection and storage or water. Underground cisterns are symbolized as wells.

g. A spring is a natural out flow of water from a subsurface level.

h. Water surface elevations are shown, when practicable, for large lakes and wide rivers, and correspond to the normal stage of water.

4.3.2.8 Water Features

The features discussed below are shown if they are equivalent to, or exceed, an area of approx. 5 mm square approx.)

a. A marsh in tidal waters is saturated land that covers and uncovers with the tide and supports reeds or grass like aquatic growths. It is symbolized as ordinary marsh or swamp, except that the shoreline is delineated as the limits of open water (sea-side) side the feature and not the mean high water line.
b. A marsh in non-tidal waters is saturated land, usually covered with standing water that supports reed or grass like aquatic growths. It is shown in the open water area with its landside limits delineated as the shoreline.
c. A swamp is land which is saturated, though not usually covered with water. Land subject to natural inundation is never regarded as swamp.
d. Mangrove is a thick impenetrable growth of trees with tangled aerial roots which appears in tropical and semitropical regions. It occurs in low lying areas along sea coasts, and along the banks of tidal waters up to the limits of the tidal influence. Where the exact location of the shoreline (mean high water) is not apparent, or unknown, the water-side limits of the feature is annotated as the shoreline and delineated by the indefinite symbol. The land side limits (mean high water) is shown when known. This feature (mangrove) is delineated both as a drainage and vegetation feature.
e. Wet and constitutes sandy areas in arid region adjacent to coastal waters; the areas are continuously wet due to water seepage.

4.3.2.9 Coastal Definitions

a. The hydrographical datum is the plane of reference for soundings. It is that stage of low tide (low water line) to which the depths are referenced.

b. Foreshore area is that area which is bare or awash at the hydrographical datum (low water) but which is covered at mean high water.

c. Offshore area is that area that is always covered by water at the hydrographical datum.

d. The shoreline in tidal waters delineates the limits of land at mean high water level.

4.3.2.10 Buildings

A building is a roofed structure of a permanent nature, usually enclosed on four sides, which serves as a dwelling, storehouse, factory, animal shelter, or has some other useful purpose. In highly developed areas they are made of metal, brick, dressed lumber, concrete, and/or masonry-type materials. In the underdeveloped areas, the buildings are not as durable as in the highly developed areas, since crude lumber, cadjan, bamboo, clay, and wattle and daub are the materials most commonly used in their construction. However, they are considered to be of permanent nature. Huts, tents and other temporary dwellings are not considered as buildings.

Scale permitting, buildings are shown wherever they exist by properly oriented individual building.

A building of which any one side is greater than 1 mm at reproduction scale shall be drawn to scale by outline.

Small (less than 1 mm) indentations, extensions and open courts shall be simplified. However, the outline will follow the predominant limits of the feature.

When buildings occur in groups and in conjunction with mapped linear features such as roads, railways, and channels (ditches), the density of the buildings and the displacement due to symbolization may make it impossible to position all the building symbols in their true positions. Often building symbols must be moved slightly to achieve a good representative building pattern portrayal. The following limiting dimensions are used when delineating buildings under these circumstances.

The minimum space between building symbol is 0.25 mm.

a. When there is a small cluster of buildings and they must be moved from their true positions to avoid coalescing with each other, a displacement not to exceed 0.5 mm is permitted. When a greater displacement is required, some buildings are omitted and the group is shown by a representative pattern of building symbols.

b. Displacement of buildings is often necessary along symbolized roads or streets because of the exaggerated width of the road symbol. In such case, the building symbol is drawn to touch the road casing of a double-line road symbol.

c. A clear space of at least 0.5 mm is shown between the road casing and the edge of the building symbol if the edge of building symbol does not touch the road casing but is less than 0.5 mm away from the road casing.

d. The building symbol is plotted in its true position wherever an open space of 0.5 mm or more exists between the edge of the building symbol and the road casing. No attempt is made to show the true ground distance between the two features.

e. A minimum space of 0.5 mm is shown between building symbol and footpaths.

f. When buildings are in clusters, it is often necessary to show the condition by a representative pattern of building symbols. The pattern should reflect the real extent of the building cluster, the relative space between buildings, and their general orientation.

g. When the density of planimetric detail is such that a selection of building must be made, the selection is based on relative importance. The order of preference for retention is:

   (1) Religious buildings.

   (2) Schools.

   (3) Buildings plottable to scale.

   (4) Identified landmark buildings.

   (5) All other buildings, as space permits.

h. When compiling from aerial photographs and when the density is such that all buildings of a random group cannot be shown, the order of retention is based on size. Buildings significantly smaller than the average-size dwellings of an area are omitted, since their inclusion tends to exaggerate the density of the area. Examples of such features are: small sheds, chicken coops, animal pens, latrines, and similar features.

i. Where space does not permit all the buildings to be shown in a row of buildings, the end buildings are shown in their true position with a representative number of buildings shown between them. The first building on either side of an open space is considered and end building.

j. When two or more dwellings are actually attached (like row-houses or town house development), they are shown by a single symbol scaled to the length of the row, with the width drawn to scale or a minimum of 1 mm. This treatment applies only in areas or developments that are not considered built-up areas.

4.3.2.11 Important Buildings

a. Building which are important because of their cultural importance, unique appearance, or construction, or orientation value, are identified by the appropriate symbol and/or by labelling.

b. Where there are numerous important buildings within a built-up area, only the most outstanding are shown. It is undesirable to have a profusion of important buildings, especially ones that require labelling, in these areas. Where a selection in required, those that are the talent, or viable from afar, have first preference for retention.

c. In the areas outside of the built-up area tints, where the selecting-out process is not required, all of the important buildings are shown by appropriate symbol and/or label.

d. Special symbols have been designed to represent the following important buildings:

(1) Religious buildings Temple, Kovil, Mosque, Church

(2) Schools

(3) Hospital, Dispensary

(4) Police Station, Court

(5) Main Post Office, Sub-Post Office

(6) Hotel, Rest House, Circuit Bungalow

4.3.2.12 Built-up Area

a. Types of Built-up Areas

Most of the large towns and cities of the island have at least a portion of their developed areas falling into the built-up area category.

1) The old-town, hard-core sections of the nucleated cities with their narrow streets and continuous roof cover.

2) The industrial and commercial districts and public buildings.

3) The urban residential areas made up of closely spaced, or attached, permanent dwellings and apartment complexes.

b. Density Requirements

1) While the degree of building density, and extent of area, are the main criteria used to determine when an area is to by shown by the built-up area

tint, or by building symbols, it is also important for the final symbolization to reflect a gradual transition in building density between the sparse and more concentrated portions of a populated place whenever such a transition actually exists.

2) When compiling the outline between areas to be represented by the built-up area tint and areas to be represented by building symbols, the density requirements for built-up areas are met when the area is so dense that the building will coalesce (run together or merge) when symbolized individually. The requirement for coalescence is satisfied only when, after having represented the streets by their proper symbolization and density to reflect the characteristics pattern of the street network, most of the buildings coalesce both side-to-side and back-to-back if drawn at their minimum size.

3) In fringe and suburban areas, the buildings may coalesce in a side-to-side direction along the street, but the space between the backs of the houses may be such that coalescence does not occur in the back-to-back direction. In this case, the area is shown by the use of a representative pattern of building symbols, with as many symbols as can be portrayed along the streets. Building symbols with proper treatment of representative pattern of building locations as well as individual building symbols used on maps are given in Appendix III.

4) Buildings in fringe areas are sometimes haphazardly located so that some of the buildings coalesce at the scale of the map and others do not. In such cases, the built-up area tint is used only if coalescence is the predominant condition.

5) When all other factors have been considered, and the density or arrangement of buildings in a particular area is such that some doubt still exists as to the appropriateness of the built-up area tint for the area, the following guides are applied: doubtful areas are shown by the tint whenever they are surrounded by (or contiguous to) areas that are obviously built-up areas; doubtful areas which are not contiguous are shown by a representative pattern of building symbols.

6) Populated places that are essentially alike receive the same treatment and type of symbolization regardless of some slight difference in degree of density.

c. Size Requirements

The size requirements for the use of the built-up area symbol are met the area is a minimum of approximately 10 mm by 10mm or its equivalent area, providing the narrowest dimension is not less than 5 mm. Areas of tightly grouped buildings which do not meet the size requirement are shown by a representative pattern of building symbols.

d. Establishing Limits of Built-up Areas

1) The limits of built-up area tint are delineated whenever possible to coincide with mapped linear features such as streams, roads, streets and railways. Where built-up area limits are not coincident with linear features, the outline is delineated to create an accurate portrayal of the populated place; the final limiting line is adjusted to eliminate small (1 mm) identifications and extensions.

2) Narrow strips of development, such as a single row of buildings extending along each side of a road, are not included within the built-up limits, regardless of the density of the buildings. These will, instead, be shown by a representative pattern of building symbols.

3) The limits of built-up area tint symbols are not based on administrative boundaries.

4) Along the periphery of the built-up area factory complexes, refineries, railway yards and port facilities, which have extensive area of open ground, are not included within the built-up area limits. These features are shown by their appropriate symbols.

   e.g: Open Areas within the Built-up Area Tint

5) Areas of little or no development falling inside the overall built-up area are excluded from the tint area, provided they are approximately 5 mm by 5 mm, or larger. All areas that are below the minimum size are included within the built-up area.

6) Parks, cemeteries, universities and hospital complexes having extensive open grounds are treated as open areas if they meet the minimum size requirements. Factory complexes and railway yards are given similar treatment. Buildings or other features in these open areas are shown as individual buildings or by appropriate symbol.

e. Summary of Built-up Area and Representative Pattern

1) Built-up area tint will be shown when the following criteria are met:

(a) When buildings, shown by their minimum size symbol, 1 mm x 1 mm will coalesce side-to-side and back-to-back due to the street network in front, sides and back and,

(b) When the area is a minimum size of 10 mm by 10 mm, or its equivalent area, providing the narrowest dimension is not less than 5mm.

2) The representative pattern of building symbols will be shown when the following criteria are met:

(a) When buildings, shown by their minimum size symbol, will coalesce side-to-side but will not coalesce back-to-back due to the street network; and

(b) When the narrowest dimension of the built-up area is less than 5 mm as specified in 1) (b) above.

4.4 Symbols used for 10k and 50k Topographic Maps

When preparing thematic maps, where no symbol is prescribed for specified topographic feature, a new symbol can be prepared and used on following conditions.

i) There is no conflict with symbols shown on maps.

ii) Any special symbol used is explained either in the legend of the map or by appropriate labelling within the body of the map, so that no uncertainty may result. See Appendix II for the Symbol Library.

4.5 Colour

Although a high-quality map is composed of many different elements, colour is one of the perceptible components noticed by end-users. This is partially due to the fact that humans have an intuitive understanding of how colours are, and should be, used to create an effective and pleasing visual experience. Nevertheless, it is not always clear to the map-maker which colours should be used to its best to convey the purpose of the product. This intuition is much like listening to a favorite music. It is known when a note is in tune or out of tune, but ordinary audiences wouldn’t necessarily have any idea of how to fix a bad note. Colour is indeed a tricky piece of the cartographic puzzle and is not surprisingly the most frequently criticized variable on computer-generated maps. This section covers the outline of the basic components of colour and the guidelines to most effectively employ this important map attribute.

4.5.1 Colour Basics

As electromagnetic radiation (ER) travels via waves from the sun (or a light source) to objects on the earth, portions of the ER spectrum are absorbed, scattered, or reflected by various objects. The resulting property of the absorbed, scattered, and reflected ER is termed “colour.” White is the colour resulting from the full range of the visual spectrum and is therefore considered the benchmark colour by which all others are measured. Black is the absence of ER. All other colours result from a partial interaction with the ER spectrum.

The three primary aspects of colour that must be addressed in map making are hue, value, and saturation. Hue is the dominant wavelength or colour associated with a reflecting object. Hue is the most basic component of colour and includes red, blue, yellow, purple, and so forth. Value is the amount of white or black in the colour. Value is often synonymous with contrast. Variations in the amount of value for a given hue result in varying degrees of lightness or darkness for that colour. Lighter colours are said to possess high value, while dark colours possess low value. Monochrome colours are groups of colours with the same hue but with incremental variations in value. As seen in Figure 4.1 "Value", variations in value will typically lead the viewer's eye from dark areas to light areas.

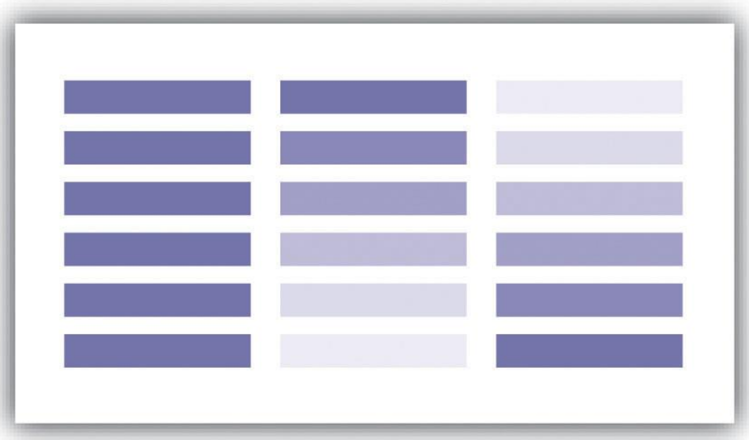


Figure 4. 1 Value

Saturation describes the intensity of colour. Full saturation results in pure colours, while low saturation colours approach gray. Variations in saturation yield different shades and tints. Shades are produced by blocking light, such as by an umbrella, tree, curtain, and so forth. Increasing the amount of shading results in grays and blacks. Tint is the opposite of shade and is produced by adding white to a colour. Tints and shades are particularly germane when using additive colour models (see Section 4.5.2 "Colour Models" for more on additive colour models). To maximize the interpretability of a map, use saturated colours to represent hierarchically prominent features and washed-out colours to represent background features.

If used properly, colour can greatly enhance and support map design. Likewise, colour can detract from a mapping product if abused. To use colour properly, one must first consider the purpose of the map. In some cases, the use of colour is not warranted. Gray scale maps can be just as effective as colour maps if the subject matter merits it. Regardless, there are many reasons to use colour. The five primary reasons are outlined here.

Colour is particularly suited to convey meaning (Figure 4.2 "Use of Colour to Provide Meaning"). For example, red is a strong colour that evokes a passionate response in humans. Red has been shown to evoke physiological responses such as increasing the rate of respiration and raising blood pressure. Red is frequently associated with blood, war, violence, even love. On the other hand, blue is a colour associated with calming effects. Associated with the sky or ocean, blue colours can actually assist in sleep and is therefore a recommended colour for bedrooms. Too much blue, however, can result in a lapse from calming effects into feelings of depression (i.e., having the “blues”). Green is most commonly associated with life or nature (plants). The colour green is certainly one of the most topical colours in today’s society with commonplace references to green construction, the green party, going green, and so forth. Green, however, can also represent envy and inexperience (e.g., the green-eyed monster, greenhorn). Brown is also a nature colour but more as a representation of earth and stone. Brown can also imply dullness. Yellow is most commonly associated with sunshine and warmth, somewhat similar to red. Yellow can also represent cowardice (e.g., yellow-bellied). Black, the absence of colour, is possibly the most meaning-laden colour in modern parlance. Even more than the others, the colour black purports surprisingly strong positive and negative connotations. Black conveys mystery, elegance, and sophistication (e.g., a black-tie affair, in the black), while also conveying loss, evil, and negativity (e.g., blackout, black-hearted, black cloud, blacklist).

Figure 4. 2 Use of Colour to Provide Meaning

In this map, red counties are those that voted for the Republican Party in the 2004 presidential election, while blue counties voted Democrat. These colours are typically used to designate the Democratic and Republican Parties.

The second reason to use colour is for clarification and emphasis (Figure 4.3 "Use of Colour to Provide Emphasis"). Warm colours, such as reds and yellows, are notable for emphasizing spatial features. These colours will often jump off the page and are usually the first to attract the reader's eye, particularly if they are counter-balanced with cool colours, such as blues and greens (see Section 4.5.3 "Colour Choices" for more on warm and cool colours). In addition, the use of a hue with high saturation will stand out starkly against similar hues of low saturation. *Red marks the spot!*

Figure 4. 3 Use of Colour to Provide Emphasis

Colour use is also important for creating a map with pleasing aesthetics (Figure 4.4 "Use of Colour to Provide Aesthetics"). Certainly, one of the most challenging aspects of map creation is developing an effective colour palette. When looking at maps through an aesthetic lens, users are truly starting to think of map creations as artwork. Although somewhat particular to individual viewers, humans have an innate understanding of when colours in a graphic/art are aesthetically pleasing and when they are not. For example, colour use is considered harmonious when colours from opposite sides of the colour wheel are used (Section 4.5.3 "Colour Choices"), whereas equitable use of several major hues can create an unbalanced image.

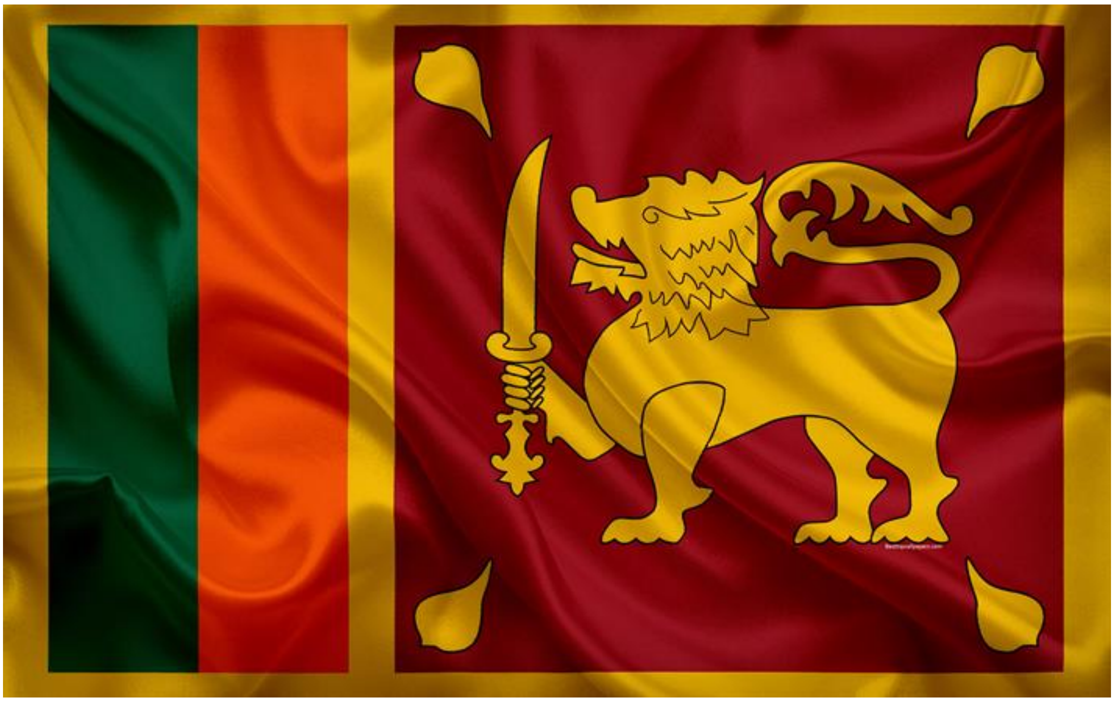


Figure 4. 4 Use of Colour to Provide Aesthetics

The fourth use of colour is abstraction (Figure 4.5 "Use of Colour to Provide Abstraction"). Colour abstraction is an effective way to illustrate quantitative and qualitative data, particularly for thematic products such as choropleth maps. Here, colours are used solely to denote different values for a variable and may not have any particular rhyme or reason. Figure 4.5 "Use of Colour to Provide Abstraction" shows a typical thematic map with abstract colours representing different zones in Sri Lanka.

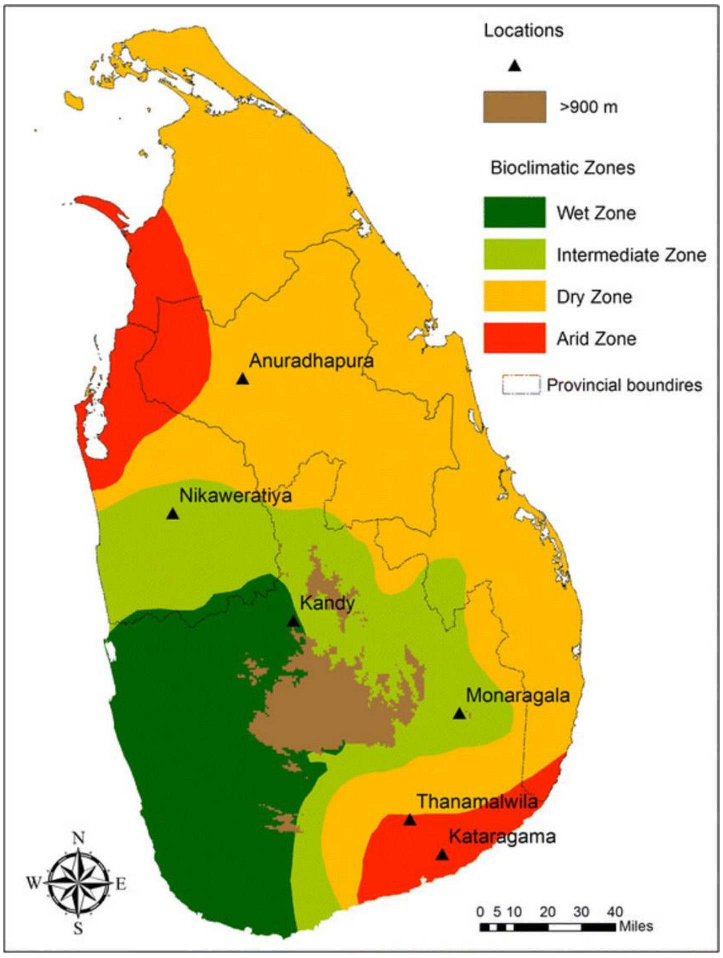


Figure 4. 5 Use of Colour to Provide Abstraction

Opposite abstraction, colour can also be used to represent reality (Figure 4.6 World Map). Maps showing elevation (e.g., digital elevation models or DEMs) are often given false colours that approximate reality. Low areas are coloured in variations of green to show areas of lush vegetation growth. Mid-elevations (or low-lying desert areas) are coloured brown to show sparse vegetation growth. Mountain ridges and peaks are coloured white to show accumulated snowfall. Watercourses and water bodies are coloured blue. Unless there is a specific reason not to, natural phenomena represented on maps should always be coloured to approximate their actual colour to increase interpretability and to decrease confusion. *Greens, blues, and browns are used to imitate real-world phenomena.*

Figure 4. 6 World Map

4.5.2 Colour Models

Colour models are systems that allow for the creation of a range of colours from a short list of primary colours. Colour models can be additive or subtractive. Additive colour models combine emitted light to display colour variations and are commonly used with computer monitors, televisions, scanners, digital cameras, and video projectors. The RGB (red-green-blue) colour model is the most common additive model. Part (a) of Figure 4.7 "Additive Colour Models: (a) RGB, (b) HSL, and (c) HSV". The RGB model combines light beams of the primary hues of red, green, and blue to yield additive secondary hues of magenta, cyan, and yellow. Although there is a substantive difference between pure yellow light (~580 nm) and a mixture of green and red light, the human eye perceives these signals as the same. The RGB model typically employs three 8-bit numeric values (called an RGB triplet) ranging from 0 to 255 to model colours. For instance, the RGB triplets for the pure primary and secondary colours are as follows:

- Red = (255, 0, 0)
- Green = (0, 255, 0)
- Blue = (0, 0, 255)
- Magenta = (255, 0, 255)
- Cyan = (0, 255, 255)
- Yellow = (255, 255, 0)
- Black, the absence of additive colour = (0, 0, 0)
- White, the sum of all additive colour = (255, 255, 255)

Two other common additive colour models, based on the RGB model, are the HSL (hue, saturation, lightness) and HSV (hue, saturation, value) models. (Figure 4.7 "Additive Colour Models: (a) RGB, (b) HSL, and (c) HSV", b and c). These models are based on cylindrical coordinate systems whereby the angle around the central vertical axis corresponds to the hue; the distance from the central axis corresponds to saturation; and the distance along the central axis corresponds to either saturation or lightness. Because of their basis in the RGB model, both the HSL and HSV colour models can be directly transformed between the three additive models. While these relatively simple additive models provide minimal computer-processing time, they do possess the disadvantage of glossing over some of the complexities of colour. For example, the RGB colour model does not define “absolute” colour spaces, which means that these hues may look differently when viewed on different displays. Also, the RGB hues are not evenly spaced along the colour spectrum, meaning combinations of the hues is less than exact.

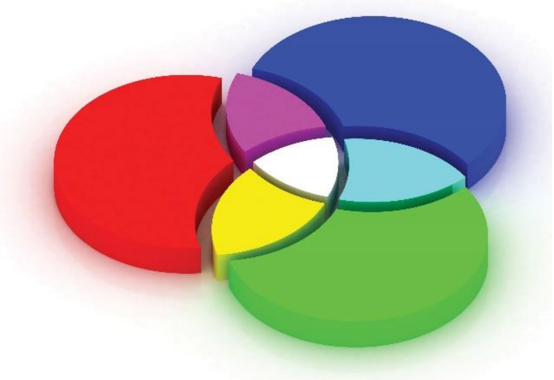


Figure 4. 7 Additive Colour Models: (a) RGB, (b) HSL, and (c) HSV

In contrast to an additive model, subtractive colour models involve the mixing of paints, dyes, or inks to create full colour ranges. These subtractive models display colour on the assumption that white, ambient light is being scattered, absorbed, and reflected from the paper by the printing inks. Subtractive models therefore create white by restricting ink from the print surface. As such, these models assume the use of white paper as other paper colours will result in skewed hues. CMYK (cyan, magenta, yellow, black) is the most common subtractive colour model and is occasionally referred to as a “four-colour process” (Figure 4.8 "Subtractive Colour Model: CMYK"). Although the CMY inks are sufficient to create all of the colours of the subtractive rainbow, a black ink is included in this model as it is much cheaper than using a CMY mix for all blacks (black being the most commonly printed colour) and because combining CMY often results in more of a dark brown hue. The CMYK model creates colour values by entering percentages for each of the four colours ranging from 0 percent to 100 percent. For example, pure red is composed of 14 percent cyan, 100 percent magenta, 99 percent yellow, and 3 percent black.

Additive models are preferred choice when maps are to be displayed on a computer monitor, while subtractive models are preferred when printing. If in doubt, it is usually best to use the RGB model as this supports a larger percentage of the visible spectrum in comparison with the CMYK model. Once an image is converted from RGB to CMYK, the additional RGB information is irretrievably lost. If possible, collecting both RGB and CMYK versions of an image is ideal, particularly if graphic is to be both printed and placed online. One last note, colour models are to be selected according the digital file format of the end product. i.e., The JPEG and GIF graphic file formats are the best choice for RGB images, while the EPS and TIFF graphic file formats are preferred with printed CMYK images.

Figure 4. 8 Subtractive Colour Model: CMYK

4.5.3 Colour Choices

Effective colour usage requires a little bit of knowledge about the colour wheel. Invented by Sir Isaac Newton in 1706, the colour wheel is a visual representation of colours arranged according to their chromatic relationships. Primary hues are equidistant from each other with secondary and tertiary colours intervening. The red-yellow-blue colour wheel is the most frequently used (Figure 4.9 "Colour Wheel"); however, the magenta-yellow-cyan wheel is the preferred choice of print makers (for reasons described in the previous section). Primary colours are those that cannot be created by mixing other colours; secondary colours are defined as those colours created by mixing two primary hues; tertiary colours are those created by mixing primary and secondary hues. Furthermore, complementary colours are those placed opposite each on the wheel, while analogous colours are located proximal to each other. Complementary colours emphasize differences. Analogues suggest harmony.

Figure 4. 9 Colour Wheel

Colours can be further referred to as warm or cool (Figure 4.10 "Warm (Orange) and Cool (Blue) Colours"). Warm colours are those that might be seen during a bright, sunny day. Cool colours are those associated with overcast days. Warm colours are typified by hues ranging from red to yellow, including browns and tans. Cool colour hues range from blue-green through blue-violet and include the majority of gray variants. When used in mapping, it is wise to use warm and cool colours with care. Indeed, warm colours stand out, appear active, and stimulate the viewer. Cool colours appear small, recede, and calm the viewer. As one can guess, it is important that you apply warm colours to the map features of primary interest, while using cool colours on the secondary, background, and/or contextual features. It should be noted *that the warm colour stands out, while the cool colour recedes.*

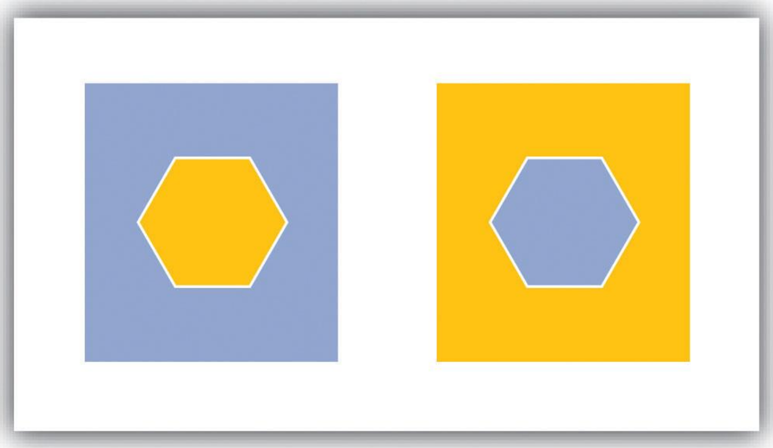


Figure 4. 10 Warm (Orange) and Cool (Blue) Colours

In light of the plethora of colour schemes and options available, it is wise to follow some basic colour usage guidelines. For example, changes in hue are best suited to visualizing qualitative data, while changes in value and saturation are effective at visualizing quantitative data. Likewise, variations in lightness and saturation are best suited to representing ordered data since these establish hierarchy among features. In particular, a monochromatic colour scale is an effective way to represent the order of data whereby light colours represent smaller data values and dark colours represent larger values. Keep in mind that it is best to use more light shades than dark ones as the human eye can better discern lighter shades. Also, the number of coincident colours that can be distinguished by humans is around seven, so be careful not to abuse the colour palette in your maps. If the data being mapped has a zero point, a dichromatic scale (Figure 4.11) provides a natural breaking point with increasing colour values on each end of the scale representing increasing data values.

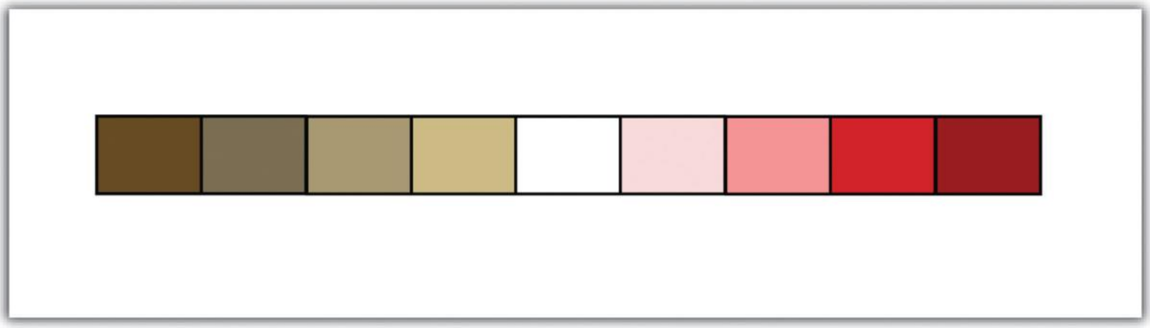


Figure 4. 11 Increasing Colour Values

A dichromatic scale is essentially two monochromatic scales joined by a low colour value in the center. In addition, darker colours result in more important or pronounced graphic features (assuming the background is not overly dark). Use dark colours on features whose visual impact you wish to magnify. Finally, do not use all the colours of the spectrum in a single map. It is best to leave such messy, rainbow-spectacular effects.

4.6 Symbols used for other Thematic Maps

Thematic maps pull in attributes or statistics about a location and represent that data in a way that enables a greater understanding of the relationships between locations and the discovery of spatial patterns in the data that we are exploring.

There are a number of visualization techniques and thematic map types that have different applications depending on the type of data that you are exploring and the type of spatial analysis that you are looking to do. The methodology and the type of map that you want to create may be different, for example, if you are exploring global shipping data, or environmental disaster impact.

There are mainly five thematic map visualization techniques that are particularly useful to decision makers, analysts, storytellers, and others who are looking to draw insights from their data, tell a powerful story, or gain a greater understanding of the world around us. Following five map types encompass these symbolization techniques.

1. A **choropleth map** is a thematic map where geographic regions are coloured, shaded, or patterned in relation to a value.
2. A **heat map** represents the intensity of an incident's occurrence within a dataset. A heat map uses colour to represent intensity
3. A **proportional symbol map** can represent data tied to a specific geographical point or data that is aggregated to a point from a wider area. In these maps, a symbol is used to represent the data at that specific or aggregate point, and then scaled by value, so that a larger symbol represents a greater value. The size of each symbol can be proportional to the value you are visualizing or you can set 3 to 5 'classes' of values allowing for comparison and classification of locations.
4. A **dot density map** uses a dot to represent a feature or attribute in your data. Some dot density maps are 'one-to-one' in which each dot represents a single occurrence or data point, or 'one to many' in which each dot represents a set of aggregated data, for example one dot may represent 100 individuals with a certain attribute. Both of these types of dot density map visualize the scatter of your data, which can provide insights into where instances of an occurrence are clustered.
5. An **animated time-series map** is more of a technique than a type, if your data has a temporal component (taking place over time), you can transform any of the above visualizations into an animated time-series map. Looking at your data over time can both improve your ability to gain insights and create a stronger and more compelling visual.

4.7 Map Colours

Topographic symbols and Colours used for map body are usually shown in the map legend. Red, Black and Yellow for Road network, Blue for all hydrography features, Brown for terrain, Black for Trigonometrical points, Red and Black for Toponomy and Boundaries, and Green, Yellow, Blue, Brown for Land use with or without patterns. Modifications of these colours may be needed occasionally on some areas under unique circumstances. Consequently, the symbol legend and other marginal information should be carefully chosen before preparing any map.

4.8 Map Abbreviations

Topographic Abbreviations are listed below with their meanings, authorized for use on the standard topographic and Thematic maps discussed in this manual. These abbreviations are suitable to use specially in 1:50,000 topographic map series and this list can be increased with new abbreviations for other common buildings in future.

A minimum number of abbreviations should be used on the map. They are employed when the space is not enough to insert full term or when term is repeated excessively. No spaces are used for abbreviations. Periods are omitted from abbreviations on the body of the map but they are normally retained in the margin.

In addition to the abbreviations listed herein, standard or commonly accepted abbreviations of time, measures and directions are authorized. e.g.- mN-meter North, km – kilometre. See Appendix III for topographical abbreviations.

4.9 Marginal Information

Marginal information is composed of items appearing in the margins of maps, which serve to identify any individual map completely. These identifications are the series name and scale, the edition number, the Sheet Name, the sheet numbers, publisher's note, on maps prepared by the Survey Department.

4.9.1. Series name and the Scale

A map series normally consists of maps of the same scale, which collectively covers a specific area, is generally assigned the geographic name of the area covered. The map scale is written as a ratio of map distance to its corresponding ground distance. Example: Sri Lanka 1:50,000 digital series (Series number also can be introduced in future).

4.9.2. Edition Number

The edition number is a specific identification based on the publication sequence of a particular map. Edition Numbers run consecutively, thus it can be assumed that a map labelled with a higher edition number contains more recent information than another print with a lower edition number.

4.9.3. Sheet Name

Generally, a map is named after its outstanding cultural or geographic feature. The name of a cultural feature is customarily chosen, but if a geographic feature is better known than any cultural feature appearing on the map, the geographic name is chosen. Sheet name is shown in Top Middle of the margin.

4.9.4. Sheet Number

Sheet Number for 1:50,000 scale maps are based on National Rectangular Co-ordinate system covering the area to be mapped. The co-ordinate system is 500,000 South and 500,000 West of 'Pidurutalagala'. Sheet Number is shown in Top right corner of the margin and as well as Bottom Left Corner under the Logo. Please see the Key diagram of 1:50,000 in Figure 2.3.

Series Number of 1:10,000 scale map is referred by the corresponding 1:50,000 map sheet covering the same area. e.g.: 61/20.

4.9.5 Publisher's note

To take responsible for the publishing of Maps, a Publisher's Note is inserted as marginal Information. This is followed by the year of revision (if any) and year of printing.

4.9.6 Other marginal Information

In addition to the identifications described above, the margin of a map contains other information important to the user in evaluating and interpreting the map.

Following marginal information is available in the 1:50,000 and 1:10,000 scaled maps prepared by the Survey Department.

1. Compilation note.
2. Co-ordinate system.
3. Reference system.
4. Elevations.
5. Geometric Information.
6. Symbol legend.
7. Administrative Index.
8. Location Diagram.
9. Copy Right note.
10. Users' note.
11. Bar scale and scale note.

4.9.6.1. Compilation note

Compilation note aids in evaluating the map and contains interpretive information. The note describes the method of preparation, identifies the source material used in compilation, gives the dates of aerial photography satellite imagery and field revision, and resolution of Image, scale of Aerial photography and field revision, and includes any special information pertinent to the particular sheet.

4.9.6.2 Co-ordinate system

Name of the projected co-ordinate system and projections, central meridian, Datum and interval of Geographical co-ordinates are shown.

4.9.6.3 Key diagram

It helps locate the map with map numbering system.

4.9.6.4 Elevation

It describes the contour interval and its measuring unit, and Bathymetric Contours.

4.9.6.5 Geometric Information

This note indicates relationship between true north, magnetic north and grid north for the major grid at the centre of the sheet. It also shows the annual change.

4.9.6.6 Symbol legend

The symbol legend defines and illustrates the symbols most commonly used such as populated places, roads and railways etc. It also contains symbols for items peculiar to the area being mapped.

4.9.6.7 Administrative Index

The Index to the boundaries identifies the Administrative area appearing in the body of the map. The boundaries in the diagram are schematic but serve as aids in locating the boundaries on the map. In 1:50,000 and 1:10,000 scale maps, this information is shown in the administrative index.

4.9.6.8 Location diagram

This is an index to adjoining sheets on 1:50,000 and 1:10,000 scale maps and its location identify the surrounding sheets.

4.10 Accuracy of Maps

Accuracy refers to the closeness of results of observations, computations, or estimates of graphic **map** features to their true value or position. Relative **accuracy** is a measure of the **accuracy** of individual features on a **map** when compared to other features on the same **map**.

4.10.1. Graphical resolution

Graphical resolution on a map is the minimum distance that can be measured of objects or between objects. On a map of 1: 10,000, 10 cm represents 1 km and on a map of 1: 50,000, 2 cm represents 1 km. It is apparent, smaller the scale, resolution decreases. According to empirical studies, minimum distance that can be estimated from a map is one fourth (1/4) of a millimetre. According to this estimation, graphical resolution of a map at the scale of 1: 10k is 2.5m on ground and it is 12.5m on ground at the scale of 1: 50k.

4.10.2. Map accuracy standards

The **National Map Accuracy Standard** (NMAS) provides insurance that maps conform to established accuracy specifications, thereby providing consistency and confidence in their use in geospatial applications.

1. **Horizontal accuracy**. For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 0.085cm, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 0.051cm. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or centre points of small buildings), etc. In general what is well defined will be determined by what is plottable on the scale of the map within 0.25mm (graphical resolution). Thus, while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 0.25mm. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map.

• If larger than 1:20,000-scale, use this calculation: 0.085 x scale / 100 = ground meters.

• If 1:20,000-scale or smaller, use this calculation: 0.051 x scale / 100 = ground meters.

Examples of Horizontal Accuracy:

• For 1:10,000-scale maps: 0.085 x 10,000 / 100 = 8.5 meters

• For 1:50,000-scale maps: 0.051 x 50,000 / 100 = 25.5 meters

2. **Vertical Accuracy**, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

5.0 Quality Control

Mapping quality is directly related to the quality of data handled at each stage of cartographic production.

5.1 Quality Control Procedures

All the Topographical & Thematic map series in the Survey Department should go through the quality control procedure. This has to be performed to enhance the quality of the map in keeping with the standards for all the printed Topographical and Thematic maps. There are number of key parameters to be checked in order to make quality control activities are they are listed as follows:.

- Positional accuracy: Plannimetric accuracy and accuracy of elevation

- Completeness: Checking for gaps of feature representation (features that should be mapped are not depicted) and inclusion of non-existent features (features that do not appear on the images are mapped out), and checks for features with incorrect shapes and geometries.

- Logical consistency: topological relationship among features, application of correct symbology, matching of features across adjoining tiles.

- Semantic quality: correct representation of feature description, definition and its classification.

- attribute precision: correct association of attributes for each feature or set of features

5.1.1 Map Layout

Checking if the correct layout is chosen based on the requirement of distribution of details, printing paper size and plate size.

5.1.2 Map Data

Checking the adequacy of data used to represent the map in accordance with the scale.

5.1.3 Enhancement and Name placement

Checking position of name placement according to the cartographic rules.

5.1.4 Legend and Colours

Checking the legend and colours to see if they are in accordance with the specification.

6.0 Printing Process

The printing process is carried out by the Lithographic Printing Branch. The branch consists of four printing sections to carry out tasks, namely, pre-press planning section, plate making section, printing section and dispatch unit.

All the map data for printing will be sent to Lithographic printing branch in portable document format (pdf) along with printed hard copy. Colour separation values of each map have to be checked at Lithographic printing branch with the help of a computer. Once the digital map in pdf format is satisfied with all the requirements, it is sent for positive preparation or computer to print (CTP) plate making.

All the forms and other booklets and pdf files are handled at Lithographic printing branch in the pre-press planning section. This section involves checking the layout and creating a final pdf file.

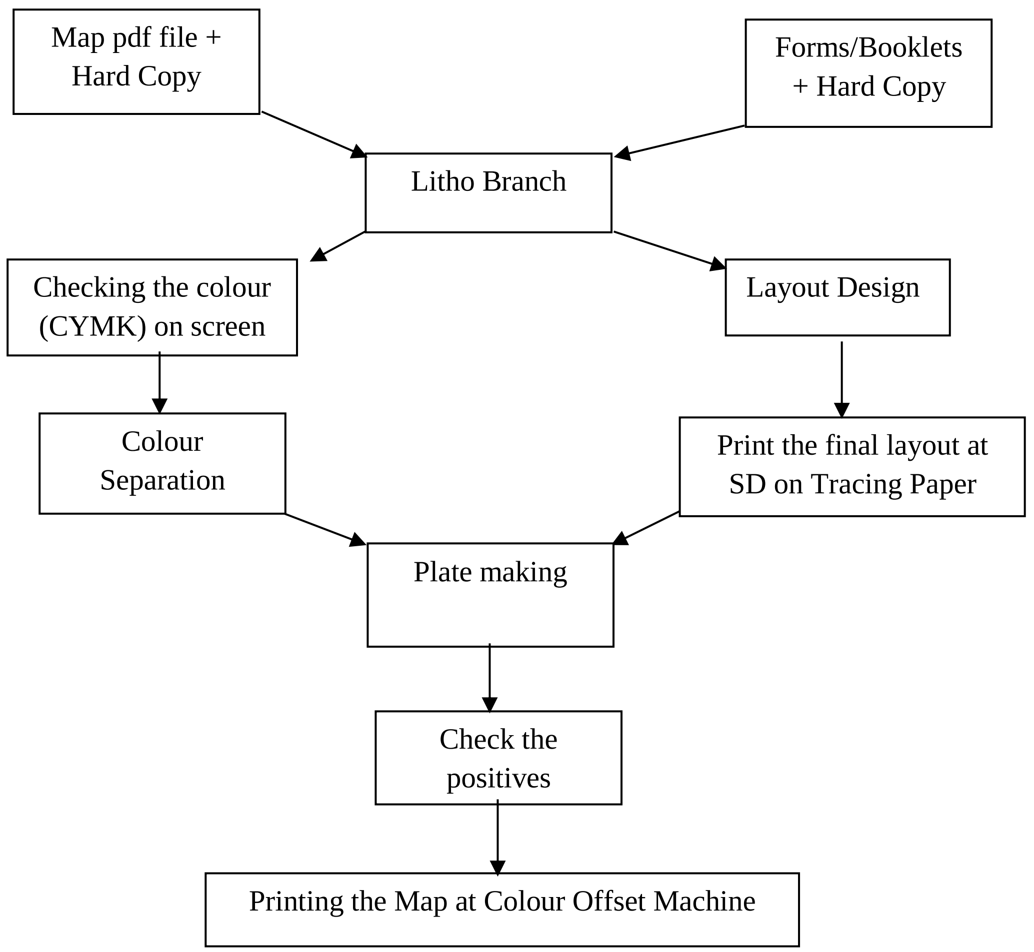


Figure 6. 1 Printing Process

7.0 Map Dissemination Methods

7.1 Introduction

This chapter describes the methodology to disseminate or distribute map production to the map user. Easy availability of a product is the main factor to make it popular among map users. In case of spatial information, the access to the information on time is vital for almost all users. So, the dissemination method used for map products should be efficient in such a way that they should not to be outdate when they are received by the user. And also the method of deployment of maps should be cost effective, hence most suitable method should be selected on case basis to have effective dissemination.

7.2 Printed Map Dissemination Methods

- Map Sales Outlet (SGO and DSOO)
  Map sale outlets are the places or dedicated shops where maps are stored for sale. They should sufficiently facilitate the customers to select the best map for their use by the use of a well-organized map catalogue and a digital inventory of different maps putting them on display at customer request. A payment for a map or a set of maps should also be arranged from the map inventory itself. The outlet should be properly arranged to have an attractive look of the map shop. Precautions are to be taken for the safety of maps to prevent any damages, deformations or colour shading to support long term storing.

- Mobile sale vehicle
  Properly arranged vehicle can be used to sale maps at places where target groups of map users stay. A reasonable amount of maps should be carried in this type of vehicle to prevent unnecessary damages or losses.

- Temporary Sale Outlet (at Exhibitions, Conferences etc.)
  Temporary sale outlets can also be established in the places where people gathered for a short term activities like Conference or Exhibition. Selective varieties and amount of maps should be carried out for this type of temporary outlet with pre estimated target.

- By Post or Courier
  A third party means that it is a delivery like post or courier services can be utilized to distribute maps to the users. Cost effective but sufficient steps to be taken to protect the map/s packing should be done for this kind of delivery.

7.3 Digital Map Dissemination Methods

- Hard media (CD, DVD, Flash drive)
  Digital maps which are in standard interoperable formats such as .SHP, .DXF, GEOTIFF, SVG etc. can be copied to any hard media like CD, DVD, Flash drive etc. and delivered to map user by using any kind of methods described in the printed map dissemination methodology.

- Email
  Digital maps can be delivered to dedicated users by email. However, there may be limitation of file size in attaching and sending digital files by email. Cloud storage web based drives such as Google Drive, One Drive are a god alternative to send heavy data files usually greater than 20MB in size.

- Internet
  Both interactive (dynamic) maps and fixed (static) maps can be distributed through the internet. Interactive maps can be published and downloaded through web map services and can be visualized in a web page or a part of web page.

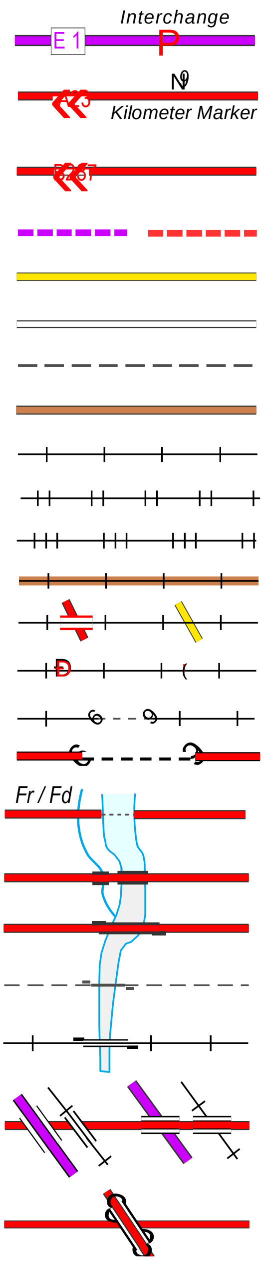
- TV
  Maps depicting important public notifications / alerts / warnings can be communicated very effectively through this media. Maps prepared for this purpose should be simple and visually appealing for any layman.

- Display Screen
  Maps made for digital displays to be prepared considering the digital characteristics of the display such as resolution, contrast, colour depth, size and surrounding environment.

Appendix I – 1:10k and 1:50k Symbol Library

a. 1:50k Map Reference of Transportation

TRANSPORTATION



Expressway

National Highway (A)

National Highway (B)

Road Under Construction
Expressway/National Highway

Secondary Road

Track

Foot Path

Road on Bund

Railway - Single Track

Railway - Double Track

Railway- Multi Track

Railway on Bund

Level Crossing Protected / Unprotectec

Railway Station / Sub Station

Railway Tunnel

Road Tunnel

Ferry /Ford

Causeway

Road Bridge

Foot Bridge

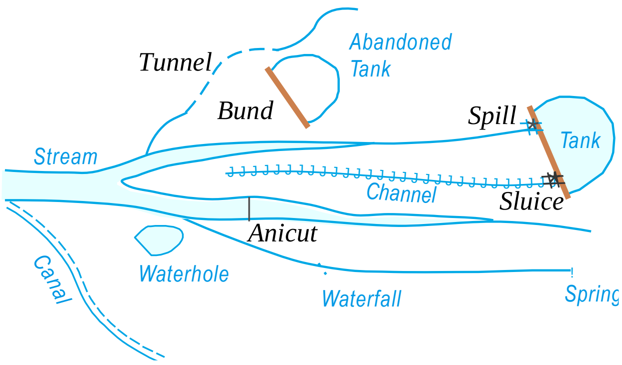
Rail Bridge

Overpass / Underpass

Flyover Bridge

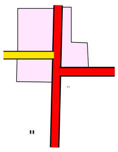
b. 1:50k Map Reference of Hydrographical Features

WATER FEATURES



c. 1:50k Map Reference of General Features

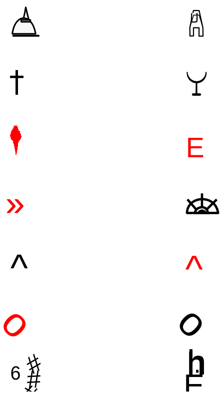
GENERAL FEATURES



Built- up Area

Building

Building Important



Buddhist Temple / Hindu Temple

Church / Mosque

School / Hospital

Post Office / Historical Site

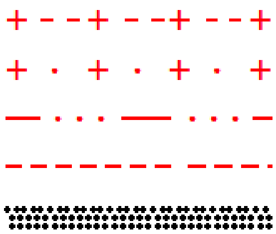
Police Station / Courts

Airport-International / Domestic

Light House or Beacon / Power Station

d. 1:50k Map Reference of Boundaries

BOUNDARIES



Province

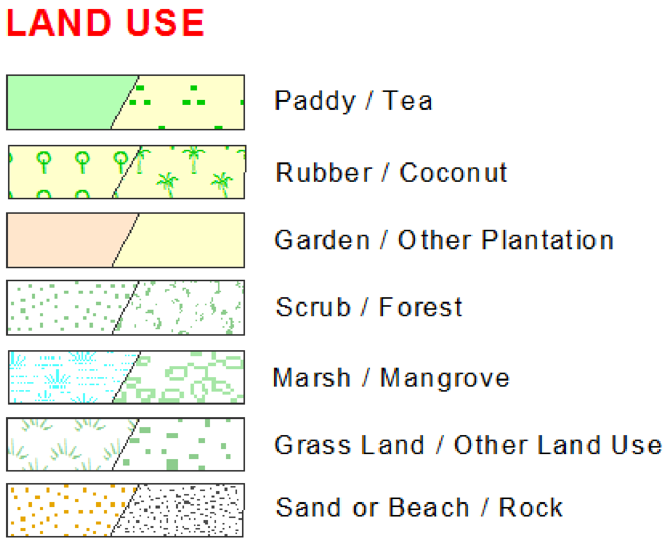
District

Divisional Secretary Division

Local Authority

Forest Reserve / National Park or Sanctuary

e. 1:50k Map Reference of Land use

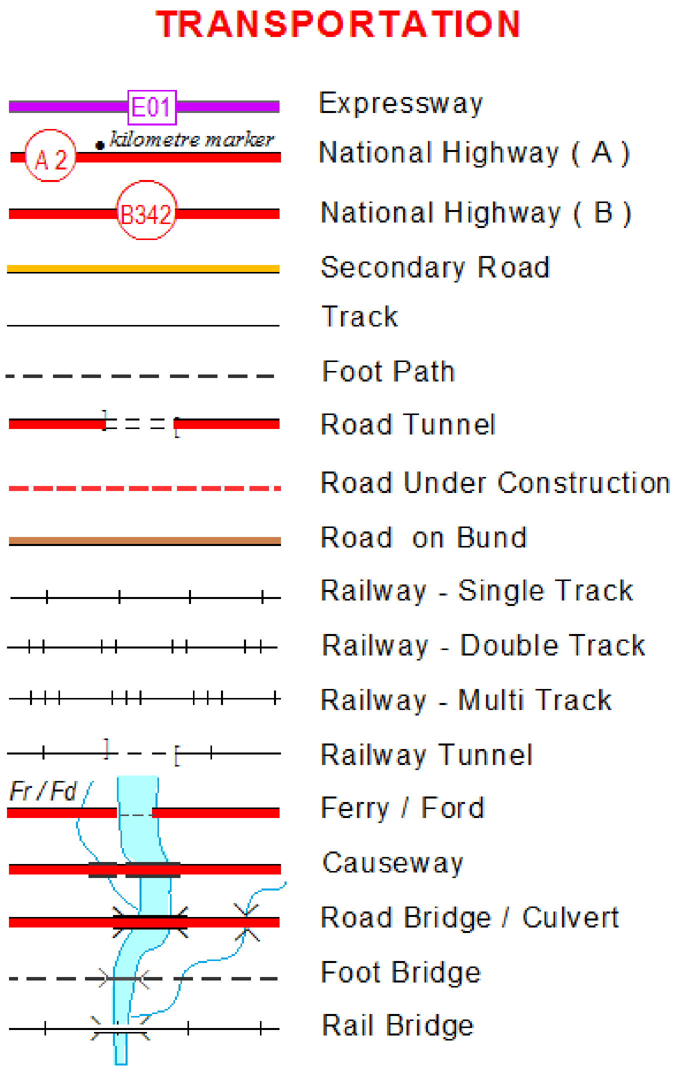


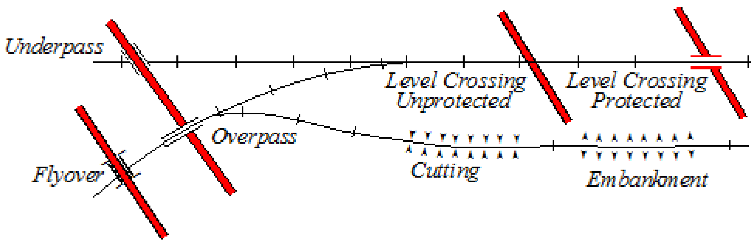
f. 1:50k Map Reference of Toponyms

TOPONYMS

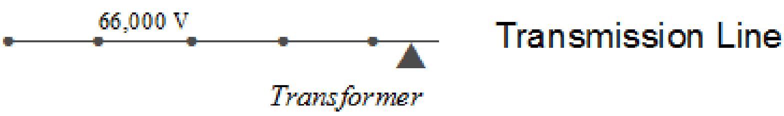
MAHA OYA	Divisional Secretary Division
KILINOCHCHI	District Capital
DAMBULLA	Other Town
KAYTS	Island
Wattahena	Village
Ashokapura / Mahara Junction	Place / Junction
POLWATTEKELE	Estate

g. 1:10k Map Reference of Transportation



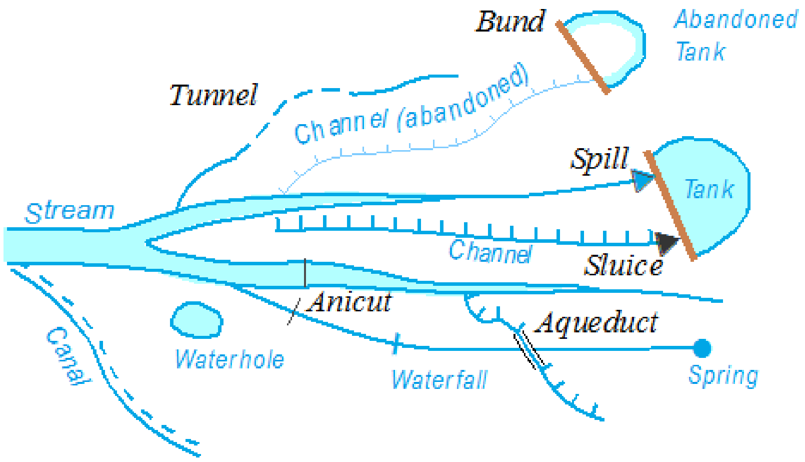


h. 1:10k Map Reference of Transmission Line



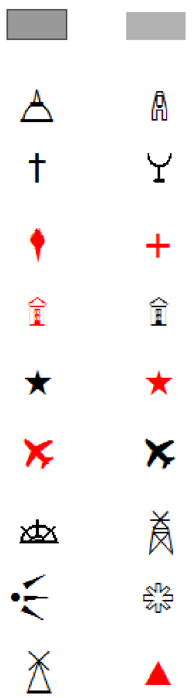
i. 1:10k Map Reference of Water Features

WATER FEATURES



j. 1:10k Map Reference of General Features

GENERAL FEATURES



Important Building / Other Building

Buddhist Temple / Hindu Temple

Church / Mosque

School / Hospital

Post Office / Sub Post Office

Police Station / Courts

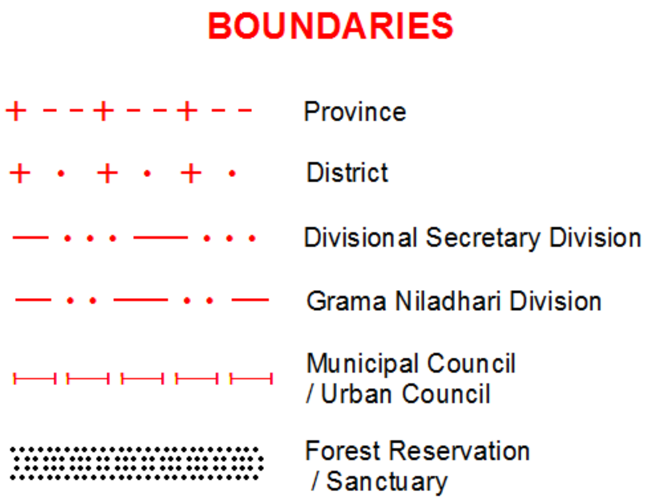
Airport-International / Domestic

Historical Site / Power Station

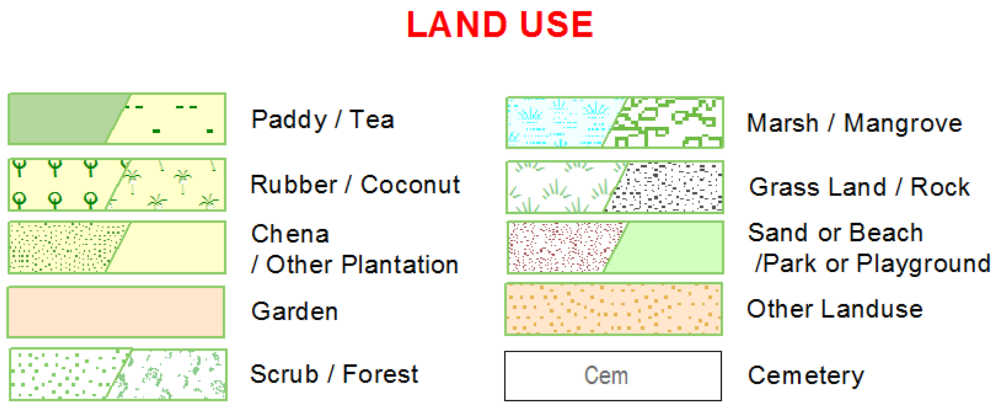
Light House or Beacon / Hotel

Wind Turbines / Filling Station

k. 1:10k Map Reference of Boundaries



l. 1:10k Map Reference of Land use

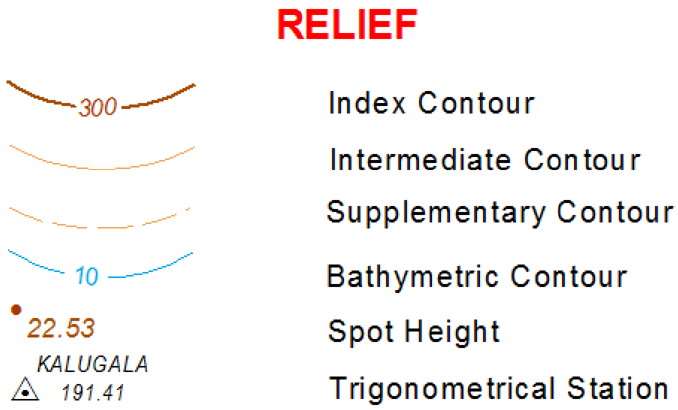


m. 1:10k Map Reference of Toponym

TOPONYM

AYAGAMA	Divisional Secretary Division
Palliyawatta	Grama Niladhari Division
KEGALLE	District Capital
WARAKAPOLA	Town
Halmessanbokka	Village
Pallegama	Place
NORWOOD GROUP	Estate
PERIYATIVU	Island

n. 1:10k and 1:50k Map Reference of Relief



Appendix II – Topographical 10k data Structure

Layer	Data layer Name	Feature Class(layer features)
1. Transportation	TR_Transport	TR_Transport_pt TR_Transport _Li
2. Hydrography	Hy_Hydro	Hy-Hydro_Pt Hy-Hydro_Li Hy-Hydro_Pg
3. Building Foot prints	CO_Building	CO_Building_Li CO_Building_Pg
4. Land Use	LU_Land use	LU_Land use_pt LU_Land use_Li LU_Land use_Pg
5. Terrain	TE_Terrain	TE_Terrain _Pt TE_Terrain_Li
6. Utility elements.	UT_Utility	UT_Utility_Pt UT_Utility_Li
6. Reserves	LU_Reserve	LU_Reserve_Li LU_Reserve_Pg
7. Toponym	CA_Toponym	CA_Toponym_Pt
8. Administrative Boundary	AD_Admin Boundary	AD_Admin Boundary_Li AD_Admin Boundary_Pg

Layer Feature	Classification 1	GFCODE	SDCODE
CO_Building_Pg	Airport	APRTA	1402
	Bank Building	BANKA	1218
	Buddhist Temple	BTMPA	1201
	Building Under Construction	BLDCA	1104
	Building -Unspecified	BLDGA	1101
	Bus Depot	BUSDA	1301
	Bus halt	BUSHA	1301
	Bus Stand	BUSSA	1301
	Cemetery Building	CMTBA	1101
	Church	CHRHA	1203
	Cinema/Theatre	CITHA	
	Circuit Bungalow	CTBNA	1216
	Commercial Buildings	CMMBA	1101
	Courts - District	DCRTA	1210
	Courts - High	HCRTA	1210
	Courts - Magistrate	MCRTA	1210
	Courts - Unspecified	UCRTA	1210
	Dispensary	DSPNA	1207
	Factory Building	FCTRA	1219
	Filling Station	FLSTA	1221
	Hindu Temple (Kovil)	HTMPA	1202
	Historical Sites	HSTSA	1104
	Hospitals – Base	BHSPA	1206

Layer Feature	Classification 1	GFCODE	SDCODE
CO_Building_Pg	Hospitals – District	DHSPA	1206
	Hospitals – General	GHSPA	1206
	Hospitals – Private	PHSPA	1206
	Hospitals – Rural	RHSPA	1206
	Hospitals – Teaching	THSPA	1206
	Hospitals - Unspecified	UHSPA	1206
	Hotel	HOTLA	1214
	Housing Scheme (Flat)	HSCHA	
	Light House	LTHSA	1217
	Mosque	MOSQA	1204
	Other Govt. Building	GVTBA	1101
	Police Post	PLCPA	1209
	Police Station	PLCSA	1208
	Port	PORTA	1403
	Post Office - Agency	APOFA	1213
	Post Office - Main	MPOFA	1211
	Post Office - Sub	SPOFA	1212
	Post Office - Unspecified	UPOFA	1212
	Pre School (Montisory/Nursery)	PRSCA	
	Private House	PTHSA	1101

Layer Feature	Classification 1	GFCODE	SDCODE
CO_Building_Pg	Railway Halt	RLHTA	2305
	Railway Station	RLSTA	2304
	Reception Hall	REPHA	
	Rest House	RTHSA	1215
	School - International	ISCHA	1205
	School - Unspecified	USCHA	1205
	Schools – Central College	CSCHA	1205
	Schools – Maha Vidyalaya	MSCHA	1205
	Schools – Other types	OSCHA	1205
	Schools – Primary	PSCHA	1205
	Schools -National	NSCHA	1205
	Schools – Private		
	Teachers Training College	TTHCA	1101
	Technical College	TCHCA	1101
	Tertiary Educational Institutes	TREIA	1101
	University	UNSTA	1101
	Water Tower (Water Board)	TOWRA	
	Building -Other types	BLDOA	
	Other Religious Building	RIGBA	

Feature	Description	GFCODE	SDCODE
CA_Grid_Li	GRID LINE	GRIDL	

Layer Feature	Classification 1	Classification2	GFCODE	SDCODE
TR_Transport_Pt	1- Node	Junction Name	JUNCP	
		Railway Crossing - Protected	RLCPP	9203
		Railway Crossing - Un protected	RLCUP	9203
		Expressway Interchange	EXINP	
		Jetty	JETYP	
	2 - Specific transport point	Helicopter Pad	HLPDP	2403
		Kilometer posts	KLMPP	2202
		Mile Posts	MILEP	

Layer Feature	Classification	GFCODE	SDCODE
TR_Transport_Li	Boat Service Route	BOATL	
	Bridge	BRDGL	2208
	Expressway	EXPRL	2101
	Expressway on Bridge	EXBRL	2101
	Expressway Overpass	EXOPL	2101
	Expressway Underpass	EXUPL	2101
	Ferry	FRRYL	2204
	Footpath (FTPHL)	FPTHL	2107
	Footpath along Tunnel	FPTNL	2107
	Footpath Old	FPTOL	2107
	Footpath on Bridge	FPBRL	2107
	Footpath on Bund	FPBNL	2107
	Footpath on Causeway	FPCWL	2107
	Foot Path on Embankment	FPEML	
	Ford (Shallow place in a river)	FORDL	2205
	Lane	LANEL	2106
	Main Roads	MNRDL	2103
	Main road along Tunnel	MRTNL	2103
	Main road on Bridge	MRBRL	2103
	Main road on Bund	MRBNL	2103
	Main road on Causeway	MRCWL	2103
	Main Road on Dam	MRDML	
	Main Road on Embankment	MREML	
	Main Road on Excavation	MREXL	
	Main Road Fly over	MRFOL	
	Main Road Overpass	MROPL	2103

Layer Feature	Classification	GFCODE	SDCODE
TR_Transport_Li	Main Road Underpass	MRUPL	2103
	Miscellaneous Line	MISCL	
	Pedestrian Cross Over Expressway	PCOEL	
	Pedestrian Cross Over Main Road	PCOML	
	Pedestrian Cross Over Railway	PCORL	

Layer Feature	Classification 1	GFCODE	SDCODE
TR_Transport_Li	Railway	RAILL	2301
	Railway (Abandoned/Dismantled)	RLABL	2306
	Railway line & Main Road on Bridge	RRBRL	2301
	Railway line along Tunnel	RLTNL	2301
	Railway line crossing protected	RLCPL	2301
	Railway line on Bridge	RLBRL	2301
	Railway line on Bund	RLBNL	2301
	Railway line on Embankment	RLEML	2301
	Railway Overpass	RLOPL	
	Railway Under Construction	RLUCL	2301
	Railway Underpass	RLUPL	
	Road Under Construction	RDUCL	2203
	Runway	RNWYL	2402
	Secondary/Minor Roads	SDRDL	2105
	Secondary/Minor Roads Old	SDROL	2105
	Secondary/Minor Road on Bridge	SRBRL	2105
	Secondary/Minor Road on Bund	SRBNL	2105
	Secondary/Minor Road on Causeway	SRCWL	2105
	Secondary/Minor Road on Dam	SRDML	2105
	Secondary/Minor Road along Tunnel	SRTNL	2105
	Secondary/Minor Road on Embankment	SREML	2105
	Secondary/Minor Road Overpass	SROPL	2105
	Secondary/Minor Road Underpass	SRUPL	2105
	Suspension Bridge	SUBRL	2208
	Taxiway	TXWYL	2401
	Jeep/Cart Track	TRCKL	2106
	Jeep/Cart Track Old	TRKOL	2106
	Track along Tunnel	TRTNL	2106
	Track on Bridge	TRBRL	2106
	Track on Bund	TRBNL	2106
	Track on Causeway	TRCWL	2106
	Track on Embankment	TREML	2106
	Track Overpass	TROPL	2106
	Track Underpass	TRUPL	2106
	Road Directions	TRANS	
	Jetty	JETYL	

Layer Feature	Classification1	Classification 2	GFCODE	SDCODE
HY_Hydro_Pt	1 - Hydro Node	Anicut	ANCTP	9307
		Flood Gate	FLGAP	3212
		SLUICE	SLCEP	3210
		SPILL	SPLLP	3209
		Water Fall	WTRFP	9306
	2 - Specific Hydro Point	Culvert	CLVTP	2212
		Spring	SPRNP	9314
		Tower (Water)	TOWRP	1303
		Tube well	TBWLP	9314
		Well	WELLP	9314
HY_Hydro_Li	1 - Water centerline	Aqueduct	AQUEL	
		Canal	CNNLL	3102
		Channel (Abandoned)	CHNAL	3102
		Irrigation Channel	CHNLL	3107
		Irrigation Channel virtual line	CHNLV	
		Spill line	SPLLL	
		Stream	STRML	3102
		Stream virtual (Line)	STRMV	
		Tunnel (Water)	TNNLL	3214
	2 - Waterarea boundary	Arcs to close all polygons in HYDRO	HYDRV	
		Boundary of Canal	CNNLL	3102
		Boundary of Irrigation Channel	CHNLL	3107
		Boundary of Reservoir	RSVRL	3111
		Bund lines	BUNDL	3207
		Canal virtual line	CNNLV	
		Irrigation Channel virtual line	CHNLV	
		Lagoon Boundary	LAGNL	3112
		Lagoon Boundary Virtual	LAGNV	
		Lake boundary	LAKEL	
		Lewaya/Salt pan Boundary	LEWYL	
		Lewaya/Salt pan Boundary Virtual	LEWYV	
		Pond boundary	PONDL	3106
		Spill line	SPLLL	
		Stream Boundary	STRML	
		Stream Boundary virtual	STRMV	
		Swimming Pool	SWMPL	3114
		Tank (abandoned) boundary	TNKAL	3110
		Tank boundary	TANKL	3109
		Tank boundary Virtual	TANKV	
		Tunnel (Water)	TNNLL	3214

Layer Feature	Classification1	Classification 2	GFCODE	SDCODE
HY_Hydro_Li	2 - Waterarea boundary	Villu Boundary	VLLUL	
		Waste Water Treatment Plant (Waste/Sewage)	WWTPL	
		Water holes boundary	WTRHL	3113
		Water Treatment Plant (Drinking)	WTPLL	
	3 - Other Water line	Anicut	ANCTL	
		Bund lines(Abandoned) - BNDAL	ATBNL	3208
		Bund under Construction/Proposed	BUNPL	
		Channel under Construction/Proposed	CHNPL	
		Dam lines	DAML	3205
		Embankment	EMBRL	7201
		External Island	ILEXL	
		Inland Island	ILINL	
		Outline of the country	OUTBL	3101
		Outline virtual	OUTBV	
		Spring	SPRNL	
		Tank under Construction/Proposed	TNKPL	
		Waterfall Line	WTRFL	

Layer Feature	Classification1	GFCODE	SDCODE
HY_Hydro_Pg	Abandoned Bund area	BNDAA	
	Abandoned channel area	CHNAA	3102
	Abandoned Tank area	TNKAA	3110
	All sea area	SEAA	
	Aqueduct Area	AQUEA	
	Bund area	BUNDA	
	Canal area	CNNLA	3102
	Irrigation Channel area	CHNLA	
	Islands area	ILNDA	
	Lagoon area	LAGNA	3112
	Lake	LAKEA	3105
	Lewaya/Salt pan area	LEWYA	
	Old Stream area	STROA	3102
	Pond area	PONDA	3106
	Reservoir area	RSVRA	3111
	Stream area	STRMA	3102
	Swimming Pool area	SWMPA	3114
	Tank area	TANKA	3109
	Tunnel area	TNNLA	3214
	Villu area	VLLUA	
	Waste Water Treatment Plant (Waste/Sewage)	WWTPA	
	Water holes area	WTRHA	3113
	Water Treatment Plant (Drinking)	WTPLA	

Layer Feature	Luse Classification 1	Luse Classification 2	GFCODE	SDCODE
LU_Landuse_Pg	1 - Cultivation area	Cashew	CSHWA	6207
		Chena	CHENA	6217
		Cinnamon	CNMNA	6205
		Citronella	CTNLA	6206
		Coconut (C)	CCNTA	6204
		Coconut Nursery	CCNNA	6204
		Mixed tree and other perennial crops	MIXDA	6212
		Oil Palm	OLPMA	6209
		Other cultivation	OTHRA	6211
		Paddy (P)	PDDYA	6201
		Paddy-abandoned	PDYAA	
		Palmyra	PLMRA	6208
		Plantation area	PLTNA	6211
		Prawn Cultivation	PRWNA	6225
		Rubber (R)	RBBRA	6203
		Sparsely used cropland	SPRSA	6213
		Sugarcane	SGCNA	6210
		Tea (T)	TEAA	6202
		Unclassified	UNCLA	
	2 - Forest area	Dense Forest	FRSDA	6216
		Forest - Unclassified (F)	FRSUA	6216
		Forest Plantation	FRSPA	6215
		Open Forest	FRSOA	6214
		Unclassified	UNCLA	
	3 - Boggy Area	Mangrove	MNGRA	6218
		Marsh	MRSHA	6220
		Swamp	SWMPA	6219
		Unclassified	UNCLA	
	4 - Bare area	Associated non-agricultural land	NLNDA	
		Barren land (BL)	BRRNA	6223
		Clay Pit	CLPTA	
		Garbage Area	GRBGA	
		Grassland	GRSLA	6222
		Gravel Pit	GRVPA	
		Scrub land	SCRBA	6221
		Unclassified	UNCLA	
		Waste Land	WASTA	6221

Layer Feature	Luse Classification 1	Luse Classification 2	GFCODE	SDCODE
LU_Landuse_Pg	5 - Rock area	Distorted surface	DSTSA	
		Quarry	QRRYA	
		Rock (RK)	ROCKA	6226
		Unclassified	UNCLA	
	6 - Builtup area	Agricultural farms	AGRCA	5202
		Airport	ARPTA	
		Aquatic farms	AQTCA	5201
		Built up area	BLTPA	5103
		Car Park	CPAKA	
		Cemetery	CMTYA	5301
		Container Yard	CTYDA	
		Homesteads/Garden (G)	HOMSA	5103
		Livestock farms	LVSTA	5203
		Park	PARKA	
		Playground	PLGDA	5102
		Reservation	RSRVA	
		Road area (only 1K)	ROADA	
		Runway area	RNWYA	
		Salt pan area	SALPA	6225
		Unclassified	UNCLA	
	7 - Sand area	Sand	SANDA	6224
	8 - Water area	All waters area	HYDRA	

Layer Feature	Classification1	GFCODE	SDCODE
LU_Reserves_Pg	Forest Reserves	RSVBA	8107
	Mahaweli Authority area	MAZBA	
	Wildlife Reserves	WLRSA	8107

Layer Feature	Classification1	GFCODE	SDCODE
CO_Toponomy_Pt	Estate Name	ESTTP	9808
	Housing Scheme	HSCHP	
	Miscellaneous point	MISCP	
	Place Names	PLCEP	9807
	Town Name	TOWNP	9807
	Trig points	TRIGP	7401
	Village Name	VILLP	9807

Layer Feature	Classification1	GFCODE	SDCODE
UT_Utility_Pt	Telecommunication Tower	TTOWP	
	Tower (Hightension)	TOWRP	1303
	TRANSFORMER STATION	TRNSP	4103
	Windmill	WNMLP	
	Wind Turbine	WNTBP	
UT_Utility_Li	Electric Wire Fence	ETWFL	
	Power House/Grid Stations	PWHSL	1222
	Power transmission line	PWERL	4102
	Water Pipe Line	WTPLL	
	Penstock line	PNSTL	
TE_Terrain_Pt	Spot Height Points	SPHTP	7404
TE_Terrain_Li	Bathematic Contours	BATHL	7106
	Depression line	DEPRL	7107
	Index Contours	INDXL	7101
	Index Contours - Uncertain	INDUL	7102
	Intermediate Contours	INTRL	7103
	Intermediate Contours - Uncertain	INTUL	7104
	Supplementary Contours	SUPPL	7105
	Uncertain Contours	UNCRL	7104

Layer Feature	Classification1	GFCODE	SDCODE
AD_Boundary_Li	Province boundary	PRVBL	8102
	District boundary	DSTBL	8103
	DS boundary	DSDBL	8104
	GN boundary	GNDBL	8105
	Local Govt. boundary	LGVBL	8106
	Exclusive Economic Zone	EEZBL	
	Contiguous Zone limit	COZBL	
	Territorial waters limit	TERBL	
	Outline of the country	OUTBL	3101
	Outline of the country - virtual	OUTBV	3101
	Arcs to close all polygons in ADMIN	ADMNV	

Extras	GN Division Name	GNDVP	9805
PR_Mahaweli_Li	Classification 1		
	Project Boundary	PRJBL	8106
	System Boundary	SYTBL	8106
	Zone Boundary	ZONBL	8106
	Block Boundary	BLKBL	8106
	Unit Boundary	UNTBL	8106

Appendix III – Abbreviations

BSt	-	Bus Stand
CBS	-	Central Bus Stand
Cem	-	Cemetery
Dept	-	Department
DistS	-	District Secretariat
DivS	-	Divisional Secretariat
MBS	-	Main Bus Stand
MC	-	Municipal Council
Mty	-	Ministry
PC	-	Provincial Council
PS	-	Pradeshiya Sabha
RS	-	Railway Station
RH	-	Railway Halt
UC	-	Urban Council

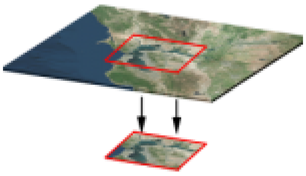
Glossary

GIS Terms

Attribute: A characteristic of a geographic feature, typically stored in tabular format and linked to the feature in a relational database. The attributes of a well-represented point might include an identification number, address, and type.

Base Layer: A primary layer for spatial reference, upon which other layers are built. Examples of a base layer typically used are either the parcels, or street centre lines.

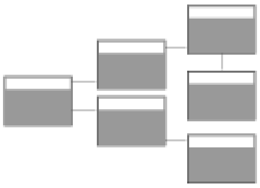
Buffer: A zone of a specified distance around a feature.



Clip: A clip is a method of overlay that involves clipping an input layer with the extent of a defined feature boundary. The result of clip operation is a new clipped output layer.

Coordinates: Coordinates are pairs (X, Y) or triplets (X, Y, Z) of values that are used to represent points and features on a two and three-dimensional space. The X-value represents the horizontal position and Y-value represents the vertical position. The Z-value generally refers to the elevation at that point location.

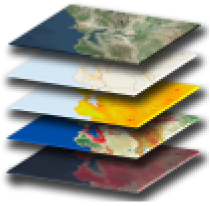
Database Management System (DBMS): A DBMS is a collection of tools that permits the entry, storage, input, output and organization of data. It serves as an interface between users and their database. A logical collection of interrelated information managed and stored as a unit. A GIS database includes data about the spatial location and shape of geographic features recorded as points, lines, and polygons as well as their attributes. Digital Elevation Model (DEM) - Terrain elevation data provided in digital form.



Database Schema: A database schema is supported in relational database management systems (RDBMS) and acts as blueprints for how database entry will be constructed.

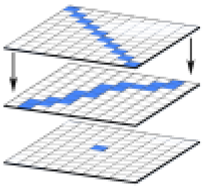
Digitize: To encode map features as x,y coordinates in digital form. Lines are traced to define their shapes. This can be accomplished either manually or by use of a scanner.

Geocode: The process of identifying a location by one or more attributes from a base layer.



Geographic Information Systems (GIS): GIS is a computer-based tool that analyzes, stores, manipulates and visualizes geographic information on a map. GIS links geographic locations on Earth with attribute information enabling users to visualize patterns, understand relationships and trends.

Global Navigation Satellite System (GNSS): A satellite based device that records x, y, z coordinates and other data. Ground locations are calculated by signals from satellites orbiting the Earth. GPS devices can be taken into the field to record data while walking, driving, or flying.



Intersect (Overlay): This is a geoprocessing operation that that uses two inputs. The input coverage can be a point, line, or polygon coverage. The output coverage will be the same feature type as the input coverage. Only those features contained by polygons in the intersect coverage will be preserved in the output coverage.

Layer: A logical set of thematic data described and stored in a map library. Layers act as digital transparencies that can be laid atop one another for viewing or spatial analysis. Line – Lines represent geographic features too narrow to be displayed as an area at a given scale, such as contours, street centrelines, or streams.

Metadata: Metadata is data about data. Metadata describes the characteristics of a dataset which includes abstract, coordinate system; attribute information, origin and accuracy.

Point: A single x, y coordinate that represents a geographic feature too small to be displayed as a line or area at that scale.

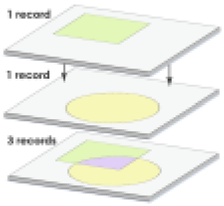
Polygon: A multisided figure that represents area on a map. Polygons have attributes that describe the geographic feature they represent.

Scale: The ratio or relationship between a distance or area on a map and the corresponding distance or area on the ground.

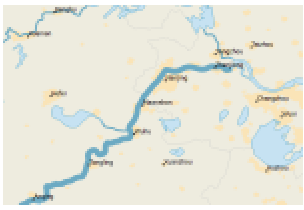
Spatial Analysis: The process of modelling, examining, and interpreting model results. Spatial analysis is useful for evaluating suitability and capability, for estimating and predicting, and for interpreting and understanding.

Structured Query Language (SQL): A syntax for defining and manipulating data from a relational database. Developed by IBM in the 1970s, it has become an industry standard for query languages in most relational database management systems.

Theme: A theme stores map features as primary features (such as arcs, nodes, polygons, and points) and secondary features such as tics, map extent, links, and annotation. A theme usually represents a single geographic layer, such as soils, roads, or land use.



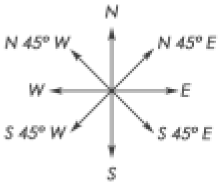
Union: The union is the process of spatially combining two data layers preserving the features from both layers at the same extents.



Vector Data Model: A vector data model is a common GIS feature representation of spatial information based on defining coordinates and attribute information. Vectors are points, polylines and polygons.

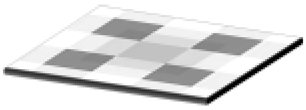
Cartographic Terms

Basemap: A basemap is a background georeferenced image that gives a point of reference on a map. Basemaps are non-editable and provides aesthetic appeal such as aerial imagery, topography, terrain and street layers.

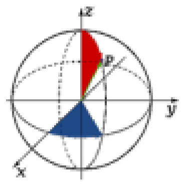


Bearing: A bearing is a direction expressed as a geographic angle measured from a base line used in surveying and navigation.

Benchmark: Benchmarks are precisely surveyed points usually marked with a brass or metal disk in the ground. Benchmark is a generic term sometimes referred as survey marks, geodetic marks and control stations.

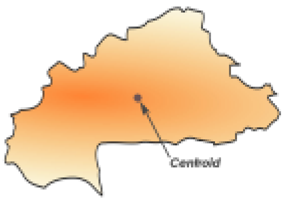


Bilinear interpolation: Bilinear interpolation is a technique for calculating values of a grid location based on four nearby grid cells. It assigns the output cell value by taking the weighted average of the four neighbouring cells in an image to generate new values.

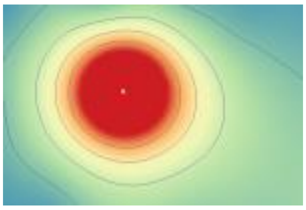


Cartesian coordinate: A Cartesian coordinate system specifies each point uniquely with a pair of numerical coordinates. Three-dimensional coordinate spaces have three axes. Each axis has a single unit of length and orientation.

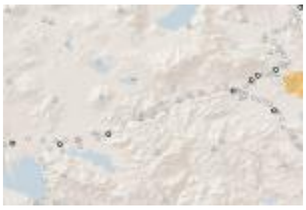
Cartography: Cartography is the study and science of representing real-world entities on maps. Cartography combines aesthetics and science to communicate spatial information in two or three dimensions.



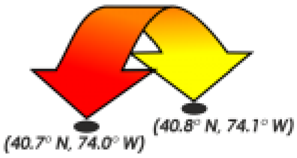
Centroid: A centroid (or geometric center) is a central point of an area feature. Centroids are defined as the average position of all the points in the shape.



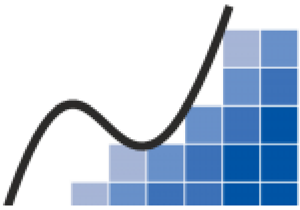
Contour Line: A contour line is a constant value for mapping any variable such as elevation and temperature maps. Contour lines are used to map equal values and illustrate topography or relief on a map. They are also known as isopleth or isoline maps.



Control point: Control points are XY locations known to have a high degree of accuracy. They are used to convert digitized coordinates from paper maps and georeferencing to standard map projection coordinates.

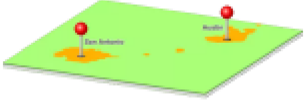


Coordinate Transformation: A coordinate transformation is the conversion from a non-projected coordinate system to a coordinate system using a series of mathematical equations.

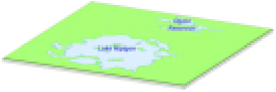


Data Model: The two main GIS data models are rasters (grids) and vectors. Rasters are sets of pixels with a specific cell size. Vectors represent points, lines and polygons.

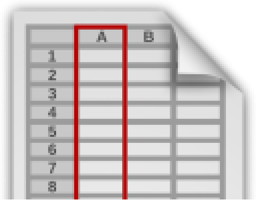
Digital Cartographic Model (DCM): Digital Cartographic model is a data structure which enables strong cartographically enhanced data where much attribute is drawn to maintain visual clearly rather than positional accuracy of data.



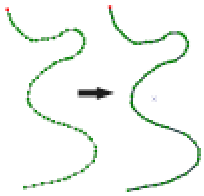
Entity: Entities represent real-world point, line or polygon features with a geographic location. Features may refer to fire hydrants, hospitals, state boundaries, roads, rivers, lakes, etc. Entities are stored in databases, where they can be retrieved and displayed using GIS software.



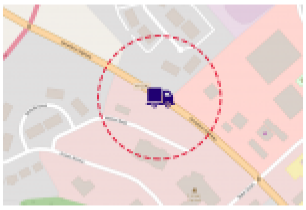
Feature: A feature is a cartographic point, line or polygon object with a spatial location in the real-world landscape that can be used in a GIS for storage, visualization and analysis.



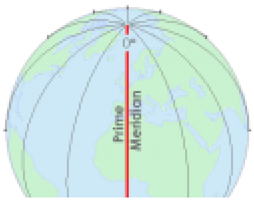
Field (Attribute Table): An attribute field (or item) are characteristics used to describe each feature in a geographic data set usually viewed as columns in a table.



Generalization Tool: The Generalization is the process of reading map details in order to accommodate space where a small scale map is prepared for a large scale map.

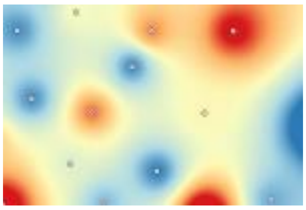


Geofencing: A virtual geographic boundary designed to give real-time alerts and increases awareness.

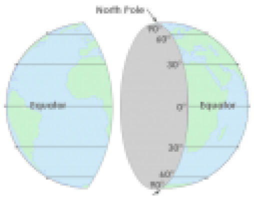


Greenwich Meridian (Prime Meridian): The Greenwich meridian is a line of longitude that passes through the Royal Observatory in Greenwich, England. In a geographical coordinate system, it is a line of longitude defined to be 0°.

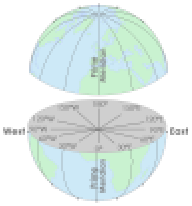
Hydrography: Hydrography is a term describing the geographic representation of water features such as streams, rivers and lakes in a GIS.



Interpolation: Interpolation is the estimation of unsampled locations based on known location sampled values. Interpolation is often used in deriving elevation, temperature and other predicted variables in a grid.



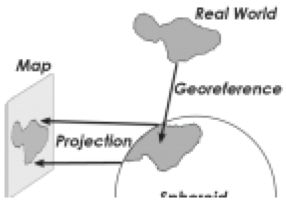
Latitude: Latitudes are spherical coordinates of Earth locations that vary in North-South directions. Lines of latitude are angles on the Earth's surface which ranges from 0° at the Equator to 90° (North or South) at the poles.



Longitude: Longitudes are coordinate on Earth that vary in east-west directions. They are usually expressed in degrees ranging from 0° to +180° east and −180° west. The prime meridian marks the 0° longitude and passes through the Royal Observatory in Greenwich, England.

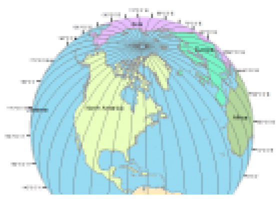
Magnetic North Pole: The magnetic north is a point in Northern Canada where the northern lines of attraction enter the Earth. Compass needles point in this direction which differs from true geographic north.

Map Legend: A map legend is a visual graphic of the symbology used in a map that tells the map reader what the polygons, lines, points or grid cells represents.

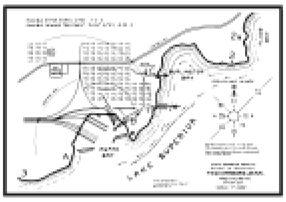


Map Projection: A map projection is a systematic rendering of features that renders a 3D ellipsoid or spheroid of Earth to a 2D map surface. Because 3D surfaces cannot be displayed perfectly in a two-dimensional space, some distortions of conformality, distance, direction, scale, and area always results from map projections.

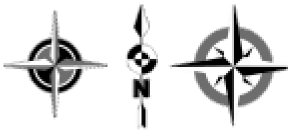
Map Representation: Choropleth maps, Heat maps,



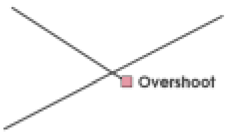
Meridian: Meridians (or lines of longitudes) are coordinate on Earth that vary in east-west directions. They are usually expressed in degrees ranging from 0° to +180° east and −180° west. The prime meridian marks the 0° longitude and passes through the Royal Observatory in Greenwich, England.



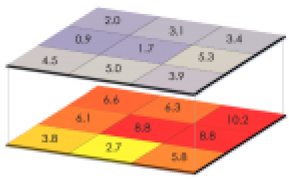
Neat Line: A neat line is a cartographic element that surrounds all the data, legend, scale and other features in a map. A neat line can be solid or multiple line border that helps map readers focus on details in the map.



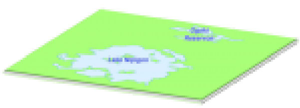
North Arrow: A north arrow gives orientation to the map reader by showing the north direction in a graphic.



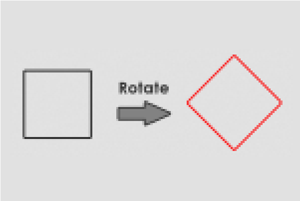
Overshoot: An overshoot is a digitized line that extend past the intended line of connection.



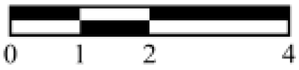
Pixels (GIS): Pixels are the grid cells that make up raster images. Each cell is identical in size and records a brightness and colour in an image.



Polygon: A polygon is a closed, connected set of lines that defines a geographic boundary with an area and perimeter. Examples are lakes, forests and country boundaries.

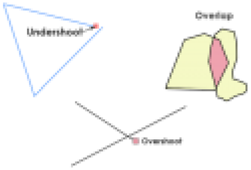


Rotate: An affine transformation changes points, polylines, polygons in a plane by scaling, rotating, skewing, or translating coordinates in two or three-dimensional spaces.

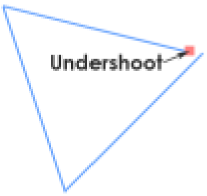


Scale Bar: A scale bar graphically shows the distance on the map with units such as kilometres or meters. Scale bars are proportional to the scale of the map.

Scale: An affine transformation changes points, polylines, polygons in a plane by scaling, rotating, skewing, or translating coordinates in two or three-dimensional spaces.

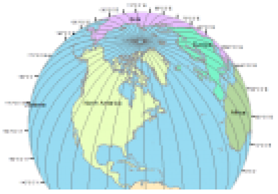


Topology: Topology is a set rules that dictates the spatial properties of point, line and area features such as connectivity, adjacency and contiguity.



Undershoot: An undershoot is considered to be a digitizing error in which the new line falls short of the intended connection segment.

Vertex: A vertex is a point that specifies a position on a line. Arcs and polylines are comprised of sets of vertices all interconnected in individual features.

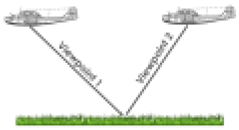


World Geodetic System 1984: WGS84 is a reference ellipsoid used for defining spatial locations in three dimensions. WGS84 is commonly used as a basis for map projections.

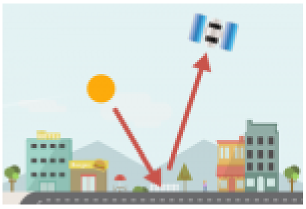
Remote SensingnTerms

Panchromatic Image: A panchromatic image records wavelengths in only one band resulting in gray scale images.

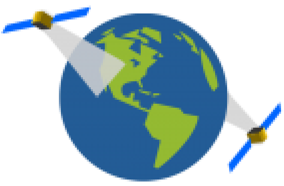
Orthophotograph: An orthophotograph is a vertical photograph with an orthographic view using geometry and measurements to reduce tilt, terrain and perspective distortions.



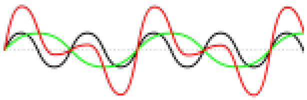
Parallax : Parallax is term used in photogrammetry that describes the apparent shift in relative positions of Earth features when it viewed in different locations.



Passive Sensors: Passive remote sensing measure natural energy from the sun as reflected sunlight or thermal radiation. Passive sensor examples are Landsat, SPOT and GeoEye.



Remote Sensing: Remote sensing is the science of obtaining information about the Earth without physically being there. Examples remote sensing techniques are by satellite, unmanned aerial vehicle and aircraft.



Wavelength: An electromagnetic wave produce sinusoidal patterns with distinguishable shape and length. A wavelength is the distance between the peak of a wave and its successive wave.

Reference

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Japan International Cooperation Agency Kokusai Kogyo Co. Ltd., Aero Asahi Corporation, JICA (2012) 'The Digital Topographic Mapping Project for Reconstruction of Northern Region Final Report', pp. 9-239

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