

# Geo-enabling Health Information Systems

UNICEF East Asia Pacific Regional Office, supported by TechNet-21, invites you to:

Learn how to geo-enable health information systems and programmes

Join us for a bi-weekly web-series starting **19 June 2024**

Demonstrate the potential of geospatial data and technologies in public health

Introduce HIS geo-enabling framework and its implementation in countries

Provide knowledge and resources to implement the HIS geo-enabling framework



Go to <https://tn21.org/UNICEF-EAPRO>  
or Scan QR Code to Register

Ongoing registration

Joining any one session also permitted

6 Modules of around 2 hours each...except module 4

Certificates provided on completion by UNICEF & MORU

# Workshop Objectives

Disseminate operational guidance materials that can assist countries in implementing the geo-enablement process for health programs in general and the development and implementation of micro plans in particular

More specifically:

- Demonstrate the potential of geospatial data and technologies in public health
- Introduce the HIS geo-enabling framework and its implementation in countries
- Transfer knowledge, expertise and resources that will allow participants to implement the HIS geo-enabling framework in their respective country

➡ At the end of this workshop, it is expected that the participants will have a better understanding of what geospatial data and technologies can bring to public health programs and how to geo-enable their health information system in a sustainable way to benefit from this type of data and technologies

➡ This is not a GIS training

# Workshop material



<https://bit.ly/4d2nfTS>

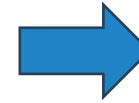


REFERENCE\_MATERIAL

PRESENTATIONS

Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

Session 1: The geographic dimension and the potential of geospatial data and technologies in public health



BIBLIOGRAPHY

GIS\_SOFTWARES

HGL\_GUIDANCE

NATIONAL\_GUIDES

Glossary of terms: <https://bit.ly/37Wje0v>

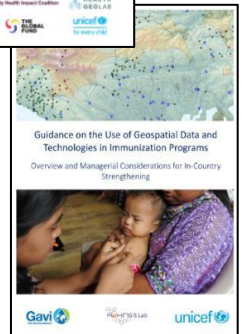
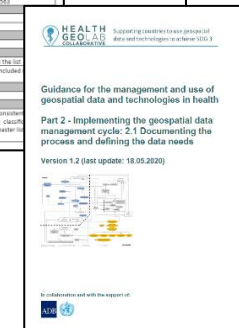
Slides and recording:

<https://healthgeolab.net/hub/resources/training-materials/unicef-regional-workshop/>



Example of data specifications

| Georeferenced master lists               |   |
|--|---|
| <b>Language</b>                          | English and local language (unofficial)   |
| <b>File format</b>                       | CSV Excel   |
| <b>Data catalog</b>                      | Covers the minimum set of data elements included in the corresponding master list data dictionary. Covers the minimum set of fields included in the corresponding master list template.   |
| <b>Geographic coordinate system</b>      | Geographic Coordinate System: UTM, WGS_1984 <ul style="list-style-type: none"><li>Angular Unit: Degree (4.0, 7.0, 10.0, 15.0, 20.0, 30.0)</li><li>Prime Meridian: Greenwich (0.0)</li><li>Datum: D_WGS_1984</li><li>Spheroid: WGS_1984</li><li>Geoid: Semimajor Axis: 6378137.0</li><li>Semimajor Axis: 6378137.0</li><li>Semimajor Axis: 6378137.0</li><li>Inverse flattening: 298.257222101</li></ul> |
| <b>Accuracy (geographic coordinates)</b> | Horizontal accuracy: 10 meters  |
| <b>Vertical accuracy</b>                 | Vertical accuracy: 10 meters (1 digit)  |
| <b>Temporal validity</b>                 | Data older than 1 year should be avoided  |
| <b>Consistency</b>                       | all the currently active records are included in the list   |
| <b>Availability</b>                      | A value is available for all the data elements included in the catalog  |
| <b>Uniqueness</b>                        | No duplicate records  |
| <b>Completeness</b>                      | When applicable, data elements values are consistent with the options included in the corresponding master list (e.g. health facility type or associated master list administrative unit name)  |



# Questions and knowledge sharing during the modules?

<https://tinyurl.com/3999y744>



Please post your questions in the Zoom Q&A (not the chat)

You can also ask questions using this short Google form (between modules for example)

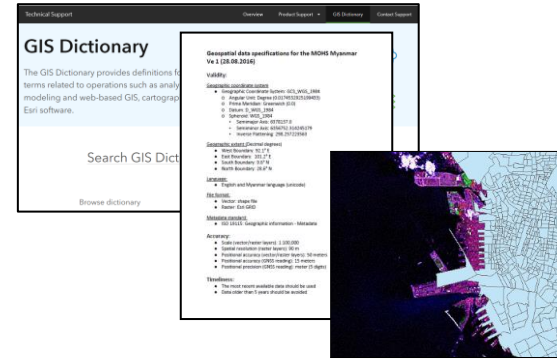
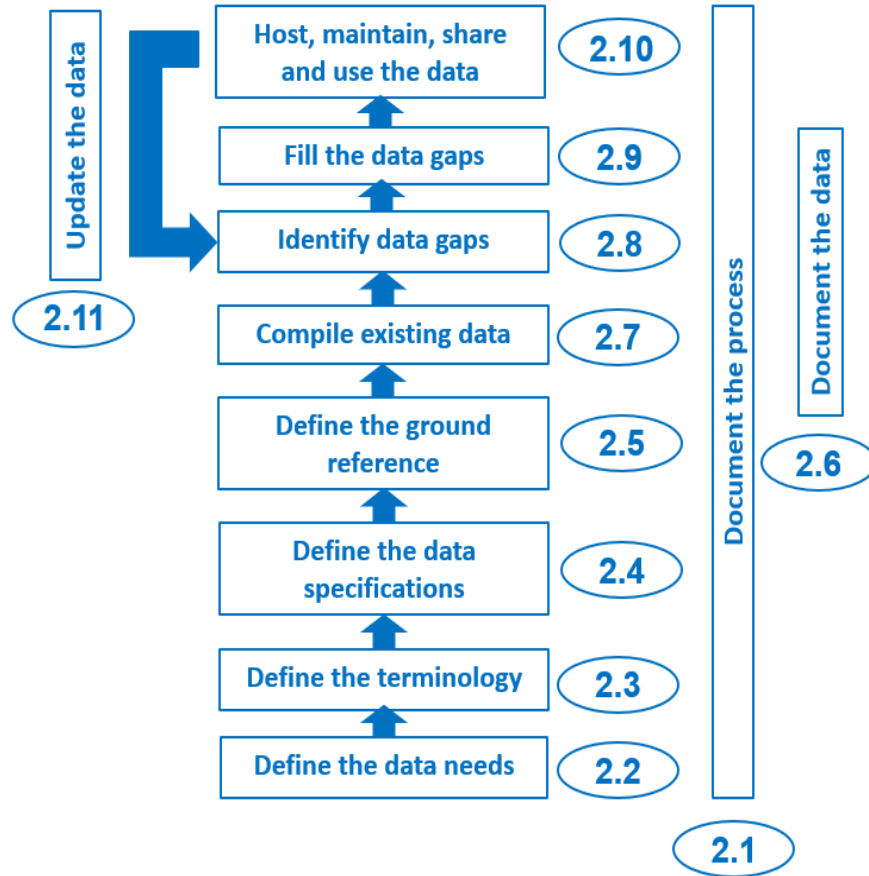
You can share any resource or experience you see relevant to the participants in the chat

We will answer them as much as possible during the modules

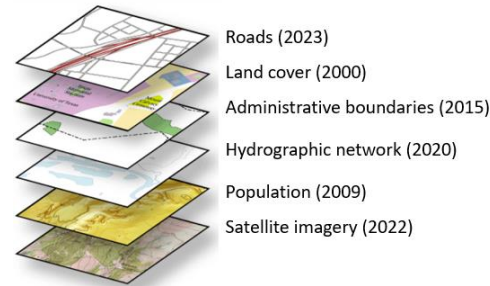
We will also be using the chat to share information



# Recap of Module 4



Terminology, data specifications and ground reference



| Nutrition Facts  |  |
|--|--|
| Serving Size 172 g   |  |
| Amount Per Serving   |  |
| Calories 200   |  |
| <b>Total Fat</b> 1 g   | <b>Title:</b> Evacuation center-level number of internally displaced people  |
| <b>Saturated Fat</b> 0g  | <b>Originator:</b> National Disaster Agency of the Middle Earth (NDAME)  |
| <b>Trans Fat</b>   | <b>Publication date:</b> 20/03/2025  |
| <b>Cholesterol</b> 0mg   | <b>Temporal validity:</b> 20/03/2025   |
| <b>Sodium</b> 7mg  | <b>Abstract:</b> This data set contains the evacuation center level number of internally displaced people due to the January 1, 2025 earthquake  |
| <b>Total Carbohydrate</b> 36g  | <b>Process:</b> This data has been collected in the field by the emergency response team deployed in the Tolken province since January 1st, 2025 |
| <b>Dietary Fiber</b> 11g   | <b>Progress:</b> Ongoing (updated daily)   |
| <b>Sugars</b> 6g   | <b>Access constraints:</b> Access to this data is limited to the authorized personnel  |
| <b>Protein</b> 13g   | <b>Use constraints:</b> Use of this data is limited to the authorized personnel  |
| <b>Vitamin A</b> 1% • <b>VitE</b>  | <b>Acknowledgment:</b> National Disaster Agency of the Middle Earth (NDAME) Response team  |
| <b>Calcium</b> 4% • <b>Iron</b>  | <b>Disclaimer:</b> This dataset is being distributed without warranty of any kind, either expressed or implied.                                  |
| *Percent Daily Values are based on a diet of other people's misadventures. |  |
| <b>Hub: NDAME</b>  |  |
| <b>Primary Contact:</b>  |  |
| Full name: Miguel Da Silva   |  |
| Organization: NDAME  |  |
| Phone number: 877-0001   |  |
| Email address: m.dasilva@ndame.gov   |  |

Metadata

| Layer                            | Source            | Resolution | Projection | Format    | Access |
|----------------------------------|-------------------|------------|------------|-----------|--------|
| Roads (2023)                     | OpenStreetMap     | 30m        | WGS 1984   | GeoJSON   | Public |
| Land cover (2000)                | FAO/UNEP          | 1km        | WGS 1984   | Shapefile | Public |
| Administrative boundaries (2015) | OpenStreetMap     | 30m        | WGS 1984   | GeoJSON   | Public |
| Hydrographic network (2020)      | OpenStreetMap     | 30m        | WGS 1984   | GeoJSON   | Public |
| Population (2009)                | Census data       | 1km        | WGS 1984   | Shapefile | Public |
| Satellite imagery (2022)         | Satellite imagery | 10m        | WGS 1984   | GeoTIFF   | Public |

Compile existing data, identify and fill data gaps



Implementation of the data management cycle

Introduction to the geospatial data management cycle

# Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

*...and beyond*

## Module 5

# Agenda - Module 5

15 min - Recap of Module 4 and agenda of Module 5

30 min – **Session 16:** Introduction to geospatial technologies

30 min - **Session 17:** Introduction to Global Navigation Satellite System (GNSS)

30 min - **Session 18:** Introduction to Geographic Information System (GIS)

30 min - **Session 19:** Introduction to the concepts of registry and Common Geo-Registry (CGR)

 Geospatial technologies

# Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

*...and beyond*

## Session 16: Introduction to geospatial technologies



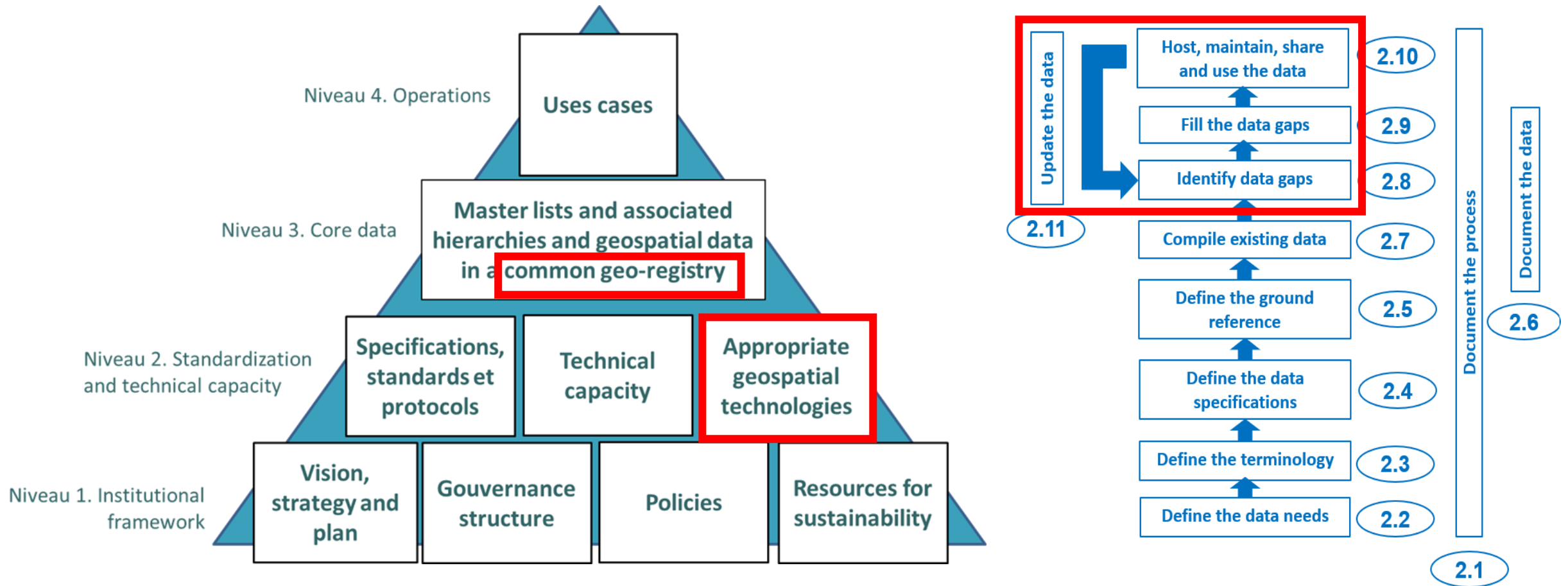
# Geospatial Technology – Definition

Set of technological approaches such as Geographic Information Systems (GIS), Global Navigation Satellite Systems (GNSS), photogrammetry, and remote sensing (RS), for acquiring and manipulating geographic data.<sup>1</sup>

This also includes new technologies that are starting to be deployed (e.g., Common Geo-Registry (CGR))

<sup>1</sup> Modified from: <https://support.esri.com/en-us/gis-dictionary/geospatial-technology>

# Place of Geospatial technologies in the HIS geo-enabling framework and geospatial data management cycle



➡ Technology supporting content and use cases, not driving them!

# Evolution of geospatial technologies

These technologies have evolved enormously over the last 50 years

1970s

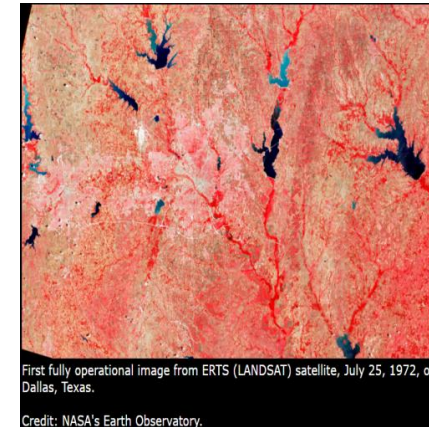
GIS



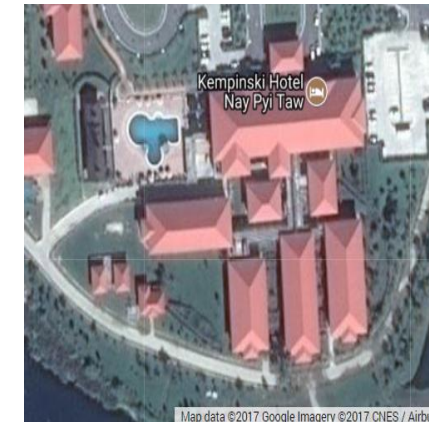
GNSS



Remote sensing



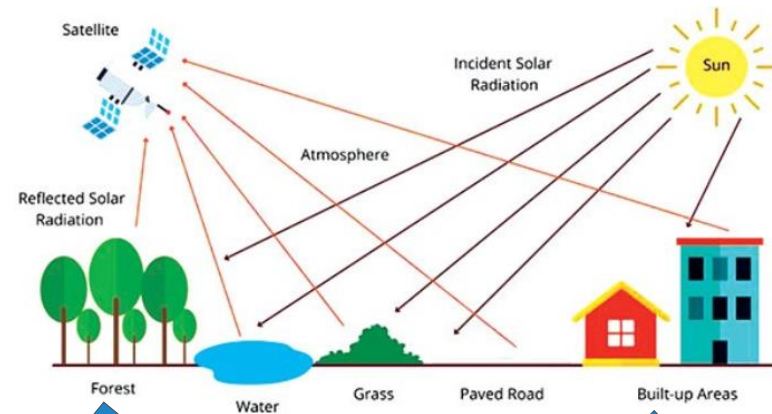
2024



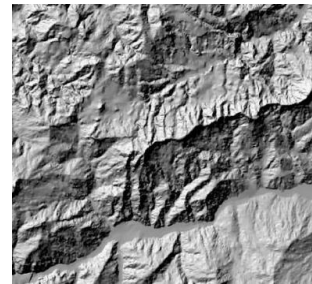
# Geospatial Technologies – Remote Sensing (RS)

**Remote sensing:** Process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft)

➡ A sensor attached to a flying object (satellite, plane, drone) captures the radiation in question



➡ Examples of derived data



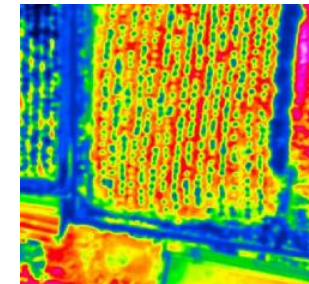
Altitude



Images



Land cover



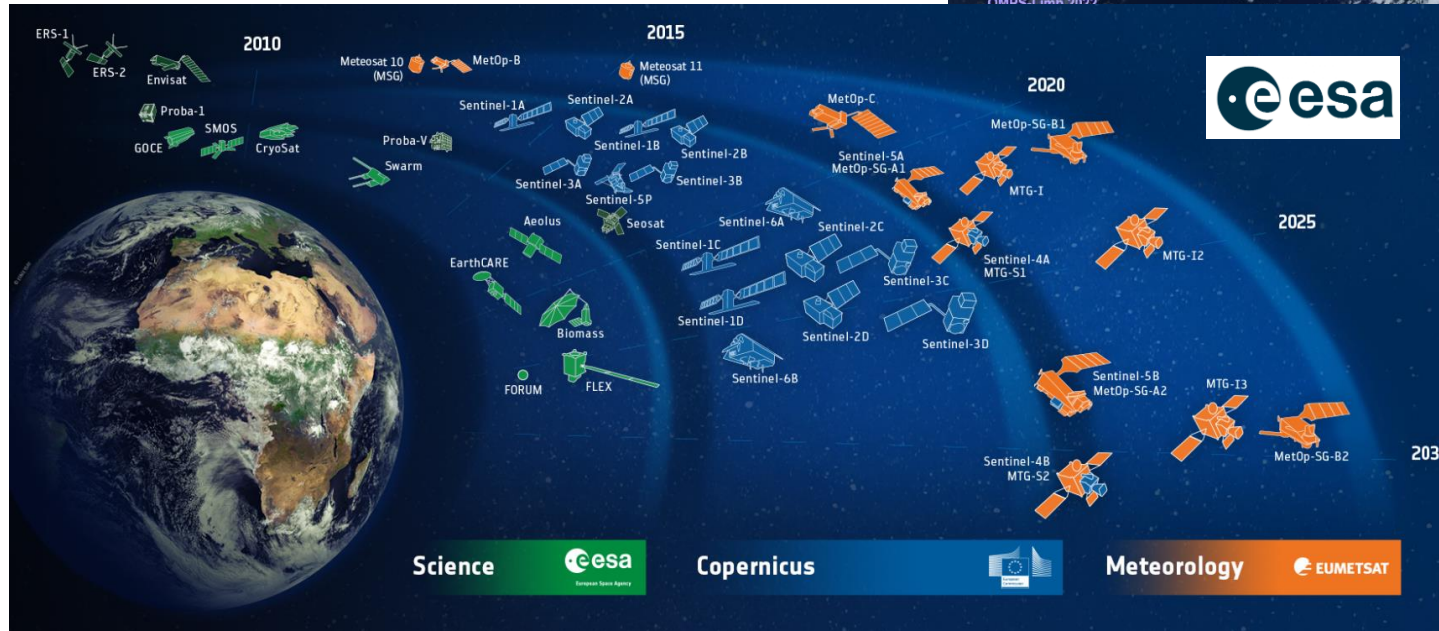
Temperature



# Geospatial Technologies – Remote Sensing (RS)

.... and there are plenty of satellites!

Only those from the National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) shown here





# Geospatial Technologies – Remote sensing to combat malaria

A use which began a long time ago and which continues to support programs to combat vector-borne diseases in particular (example for Malaria presented here)

1994

Ecological Applications, 4(1), 1994, pp. 81-90  
© 1994 by the Ecological Society of America

## REMOTE SENSING OF TROPICAL WETLANDS FOR MALARIA CONTROL IN CHIAPAS, MEXICO<sup>1</sup>

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**Abstract.** Malaria, transmitted by anopheline mosquitoes, remains a serious health problem in the tropics. Most malaria eradication efforts focus on control of anopheline vectors. These efforts include the NASA Di-Mod project, whose current goal is to integrate remote sensing, geographic information systems (GIS), and field research to predict anopheline mosquito population dynamics in the Pacific coastal plain of Chiapas, Mexico. Field studies demonstrate that high larval production of *Anopheles albimanus*, the principal malaria vector in the plain, can be linked to a small number of larval habitat-types, determined by larval sampling and cluster analysis of wetlands in the coastal plain. Analysis of wet and dry season Landsat Thematic Mapper (TM) satellite imagery identified 16 land cover units within an 185-km<sup>2</sup> study area in the coastal zone. A hierarchical approach was used to link the larval habitat-types with the larger land cover units and make predictions of potential and actual low, medium, and high anopheline production. The TM-based map and GIS techniques were then used to predict differences in anopheline production at two villages, La Victoria and Efraín Gutiérrez. La Victoria was predicted to have much higher *Anopheles albimanus* production, based upon a 2–10 times greater extent of medium- and high-producing land cover units in its vicinity. This difference between villages was independently supported by sampling (with light traps) of adults, which were 5–10 times more abundant in La Victoria.

**Key words:** Chiapas, Mexico; Landsat Thematic Mapper (TM); malaria; mosquito ecology; remote sensing; tropical wetlands.

### INTRODUCTION

Malaria is a serious global health problem with 100 × 10<sup>6</sup> new clinical cases annually in the tropical and subtropical countries of the world (WHO 1987). The epidemiological situation in these countries is complex, and efforts to control the spread of the disease have met with obstacles. These include an increase in the resistance to antimalarial drugs by the *Plasmodium falciparum*, one of the four parasite species that cause malaria (WHO 1986a), and an increase in the resistance to insecticides by the anopheline mosquito vectors that transmit the disease (WHO 1986b). Major efforts are being made to develop a vaccine, but significant problems remain to be solved (Cherfas 1990, Marshall 1990), and it is probable that for the next

decade or more, malaria control efforts will rely upon the control of anopheline vectors.

In response to this need the Life Sciences Division of the National Aeronautics and Space Administration (NASA) initiated the Biospheric Monitoring and Disease Prediction (Di-Mod) project (see *Acknowledgments*). A major objective of the Di-Mod project is to integrate remote sensing, geographic information systems (GIS), and field research to predict anopheline mosquito population dynamics in regions where malaria is endemic (Wood et al. 1989, Roberts et al. 1991).

Two hypotheses being tested are: (1) for a given malaria endemic area, anopheline mosquito production is spatially and temporally variable, and (2) this variability is controlled by environmental conditions that can be detected with spaceborne sensors. We focused efforts on mosquito larval ecology because of the direct links between environment, larvae, and mosquito produc-

2005

Parasitology 131: 81–90, 2005

## Application of Geographical Information Systems and Remote Sensing technologies for assessing and monitoring malaria risk

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<sup>1</sup>International Research Institute for Climate Prediction, The Earth Institute, Columbia University, Palisades, NY, USA; <sup>2</sup>Unité Santé, Environnement, Climat, CERME – BP 10887 Niamey, Niger; Réseau International des Instituts Pasteur

**Abstract.** Despite over 30 years of scientific research, algorithm development and multitudes of publications relating Remote Sensing (RS) information with the spatial and temporal distribution of malaria, it is only in recent years that operational products have been adapted by malaria control decision-makers. The time is ripe for the wealth of research knowledge and products from developed countries be made available to the decision-makers in malarious regions of the globe where this information is urgently needed. This paper reviews the capability of RS to provide useful information for operational malaria early warning systems. It also reviews the requirements for monitoring the major components influencing emergence of malaria and provides examples of applications that have been made. Discussion of the issues that have impeded implementation on a global scale and how these barriers are disappearing with recent economic, technological and political developments are explored, and help pave the way for implementation of an integrated Malaria Early Warning System framework using RS technologies.

**Key words:** malaria, epidemic, Remote Sensing, Geographical Information Systems, Early Warning System.

Given its impact on populations and the gravity of its pathology, malaria remains one of the most significant infectious diseases. Malaria is a leading cause of morbidity and mortality in the developing world, especially sub-Saharan Africa where the transmission rates are highest and where it is considered to be a major impediment to economic development (Sachs and Malaney, 2002). Malaria is a preventable and curable disease whose causal agent, a *Plasmodium* sp. parasite, is transmitted throughout the globe by a select number of *Anopheles* vector mosquitoes. It is essentially an environmental disease since the vectors require specific habitats with surface water for reproduction, humidity for adult mosquito survival and the development rates of both the vector and parasite populations are influenced by temperature. In sub-Saharan Africa the pattern of malaria transmission varies markedly from region to region, depending on climate and biogeography, and broad ecological categories have been widely used to describe variations in the observed epidemiological patterns (Monciet et al. 1993). Towards either end of this spectrum of variation malaria transmission is classified as stable or unstable (Gilles, 1993). A region prone to stable malaria is characterized by high transmission levels with little inter-annual variation. In these areas, collective immunity to the disease in the population is high and epidemics are unlikely. A region

prone to unstable malaria is characterized by transmission levels that vary from year to year. In these areas, collective immunity is low and disease, when it does occur, affects all age groups and is often severe (Wernsdorfer and McGregor, 1988). Unstable malaria areas are essentially found in warm, semi-arid zones, tropical mountainous areas, and regions where previous levels of control are beginning to fail. It has long been known that in these areas any change in temperature, relative humidity or rainfall can have a major impact on malaria transmission, possibly leading to epidemics (Najera, 1988).

Although tremendous progress has been made globally in fighting the vector and the parasite (Najera, 1989), the situation is far from being resolved, especially in Africa. Since 1993 there has been a pragmatic global malaria control strategy based on a Primary Health Care approach. Its aims are to: a) reduce mortality and the negative social and economic consequences of the disease; b) prevent epidemics; c) protect malaria free areas; d) eradicate malaria where possible (WHO, 1993). Such a control strategy requires recognition of the underlying variability in the epidemiology of the disease, potential for modification, availability of resources and need to adapt malaria control planning to local conditions in areas where there is a reasonable chance of success.

One of the new approaches to better understand the variability in the epidemiology of the disease depends on knowledge of biodiversity. Specifically, the distribution and ecology of the vectors and the parasites are considered within a context of a climatic and anthropogenic environment which is in perpetual evolution.

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2017

3rd ICORS 2017

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IOP Publishing

doi:10.1088/1755-1315/165/1/012012

## Application of Remote Sensing and GIS for Malaria Disease Susceptibility Area Mapping in Padang Cermin Sub-District, District of Pesawaran, Lampung Province

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<sup>1</sup>Cartography and Remote Sensing, Department of Science Information Geography, Faculty of Geography, Gadjah Mada University, Yogyakarta 55281, Indonesia

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**Abstract.** Malaria is epidemiologically a specific local infectious disease and can be studied spatially by taking into account the characteristics of malaria vector habitat. Padang Cermin Sub-District, District of Pesawaran, Lampung Province is one of the endemic areas of malaria which is geographically a coastal area dominated by water-flooded land use. That area supports the breeding and living place of *Anopheles* sp. mosquitoes. The objectives of this study were mapping the malaria disease susceptibility area in Padang Cermin sub-district by using Landsat 8 imagery, identified the influence of physical environmental factors on the spread of malaria disease, and analyzed the spread of malaria disease based on environmental factors. The research method used scoring and overlay spatial analysis of spatial parameters supporting the breeding of malaria vector. Some parameters that can be extracted through Landsat 8 imagery for identification of malaria susceptibility, i.e. land use, soil texture, vegetation density with overall mapping accuracy of vegetation density, land use, and soil texture are 83.2%, 88.7%, and 83.7%, while other parameters resulted from spatial analysis of non-remote sensing data, i.e. temperature, rainfall, slope, altitude, and distance to river. These parameters are environmental factors that influence the spread of malaria. The results of the identification of malaria susceptibility showed that the areas with high levels of susceptibility are Sidodadi, Sukajaya Lampung, Gebang, Padang Cemran, Hanu Berak, Way Urang, Taubangan, Hanu, Banjara and Sanga Village. This study showed that areas which are located on the coast are prone to malaria disease.

### 1. Introduction

Malaria is a disease caused by the *Plasmodium* parasite which is transmitted by the female *Anopheles* sp. mosquito [7]. Malaria is a life-threatening health problem that almost happened in every Indonesia's regions. Malaria disease problem is not only experienced by Indonesian, but this endemic disease can cause death and also threaten communities in various parts of the world, particularly in tropical and subtropical countries. According to World Health Organization data (2016), nearly half of the world's population is at risk of malaria. In 2015, there were roughly 212 million malaria cases and an estimated 429000 malaria deaths.

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2021

McMahon et al. Int. J. Health Geogr. (2021) 20:20  
https://doi.org/10.1186/s12942-021-00282-0

International Journal of Health Geographics

RESEARCH

Open Access

## Remote sensing of environmental risk factors for malaria in different geographic contexts

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### Abstract

**Background:** Despite global intervention efforts, malaria remains a major public health concern in many parts of the world. Understanding geographic variation in malaria patterns and their environmental determinants can support targeting of malaria control and development of elimination strategies.

**Methods:** We used remotely sensed environmental data to analyze the influences of environmental risk factors on malaria cases caused by *Plasmodium falciparum* and *Plasmodium vivax* from 2014 to 2017 in two geographic settings in Ethiopia. Geospatial datasets were derived from multiple sources and characterized climate, vegetation, land use, topography, and surface water. All data were summarized annually at the sub-district (kebele) level for each of the two study areas. We analyzed the associations between environmental data and malaria cases with Boosted Regression Tree (BRT) models.

**Results:** We found considerable spatial variation in malaria occurrence. Spectral indices related to land cover greenness (NDVI) and moisture (NDWI) showed negative associations with malaria, as the highest malaria rates were found in landscapes with low vegetation cover and moisture during the months that follow the rainy season. Climatic factors, including precipitation and land surface temperature, had positive associations with malaria. Settlement structure also played an important role, with different effects in the two study areas. Variables related to surface water, such as irrigated agriculture, wetlands, seasonally flooded waterbodies, and height above nearest drainage did not have strong influences on malaria.

**Conclusion:** We found different relationships between malaria and environmental conditions in two geographically distinctive areas. These results emphasize that studies of malaria-environmental relationships and predictive models of malaria occurrence should be context specific to account for such differences.

### Introduction

According to the United Nations Sustainable Development Goals (SDGs), combating diseases, including mosquito-borne diseases such as malaria, is a high priority. In particular, malaria is the focus of ongoing efforts toward

control and elimination [1–4]. There has been significant progress in reducing the burden of malaria, but it remains a major public health concern with 229 million malaria cases and 409,000 malaria deaths globally in 2019 [5]. The goal is to reduce these numbers by enabling access to prevention, diagnostic testing and treatment for all people [6]. However, global funding to achieve these goals is limited [7, 8]. It is essential to use available resources efficiently by spatially targeting prevention, control, and elimination efforts. Therefore, identifying areas with high

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Full list of author information is available at the end of the article

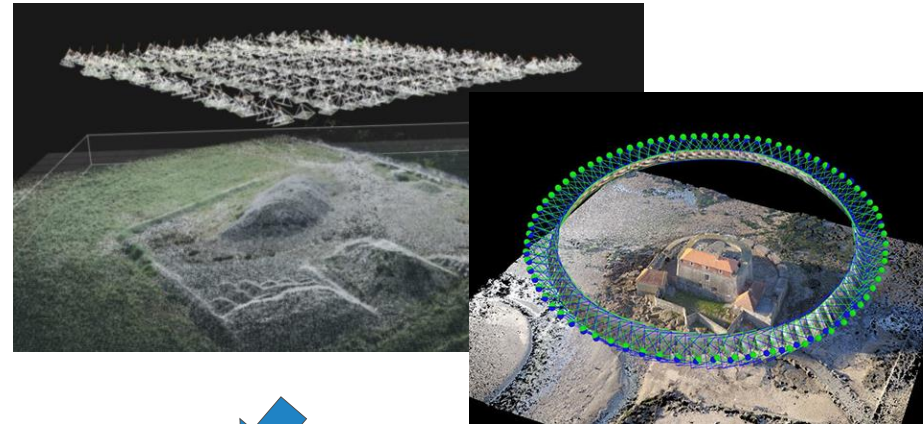
**BMC**

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# Geospatial Technologies – Photogrammetry

**Photogrammetry:** Determination of the dimension of objects, by means of measurements made on photographic perspectives of these objects.

➡ A camera is attached to a flying object or to the ground



➡ Examples of derived data



Topography



3D views

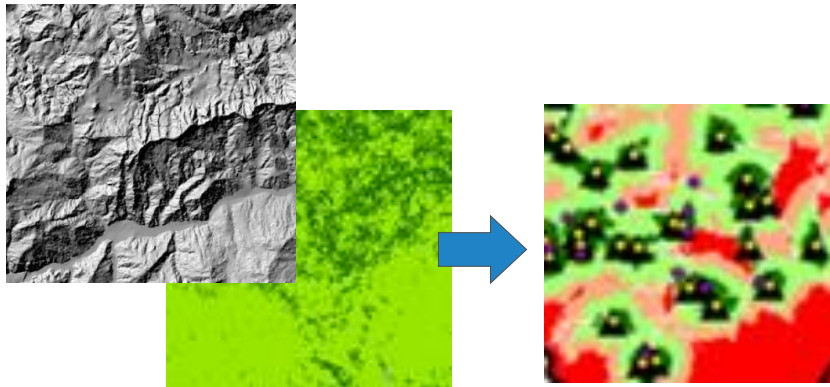


# Use of remote sensing and photogrammetry for other applications



Automatic, or semi-automatic, extraction of geographic features visible on satellite (or other) imagery including building footprints which are core to population estimation and spatial distribution (Session 15)

Using satellite (or other) imagery as a ground reference to assess and improve the quality of geospatial data (Session 15)



Use of the digital elevation model and land cover to analyze accessibility to care

➔ Remote sensing and photogrammetry generates key geospatial data needed to operationalize several of the applications of geospatial data and technologies

# Geospatial Technologies – Global Navigation Satellite Systems (GNSS)

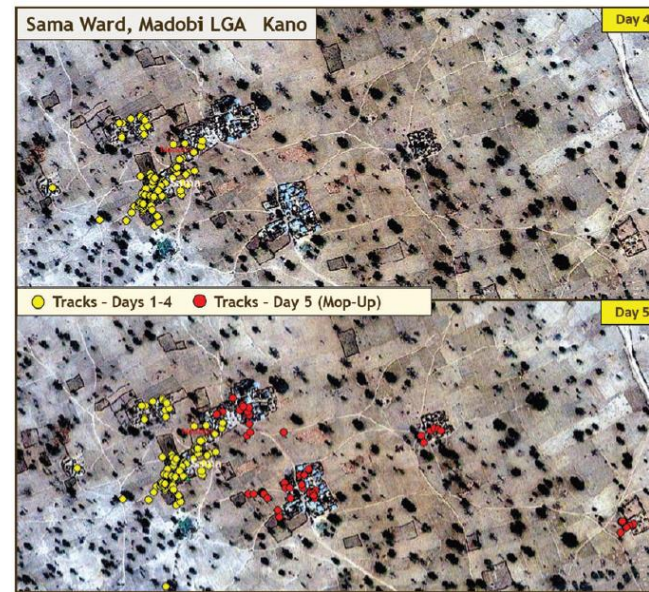
Use of a Global Navigation Satellite System (GNSS) enabled device to get to a particular location (navigate), track movements or collect geographic coordinates (latitude, longitudes) in the field



Global Navigation Satellite System (GNSS)



Navigation



Tracking to support Polio eradication in Nigeria

Collection of geographic coordinates in the field



➡ Covered in more details in Session 17



# Geospatial Technologies – Geographic Information Systems (GIS)

Two types of definitions

“A **computer system** that analyzes and displays geographically referenced information”

“**Computer tool** for representing and analyzing all the things that exist on earth as well as all the events that occur there”

➡ GIS as a geospatial technology - software

“**Information system** designed to collect, store, process, analyze, manage, and present all types of spatial and geographic data”

“**Information system** set up by an organization to describe the spatial objects, phenomena, and processes that are necessary for its action “

➡ GIS as an information system

➡ Often a source of confusion

➡ Both covered in more details in Session 18



# Geospatial Technologies – Registries and Common Geo-Registry (CGR)

**Registry:** IT solution to store, maintain, validate, update and share a master list.

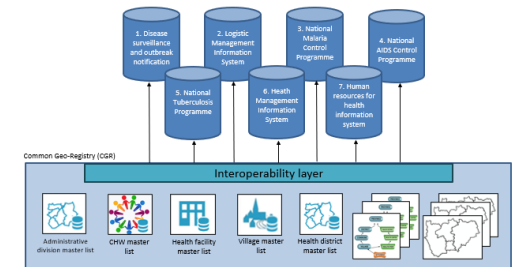
- ➔ Container that manages only one master lists and potentially its associated hierarchies and geospatial data



The official national reference directory or master list of health facilities in the Philippines.

**Common Geo-Registry:** IT solution that allows the simultaneous hosting, management, regular update, and sharing of master lists as well as associated hierarchies and geospatial data for the geographical objects core to development in general and public health in particular.

- ➔ Container that simultaneously manages multiple master lists and their associated hierarchies and geospatial data



- ➔ Both covered in more detail in Session 19

# ...and in the end

Please remember that:

- Technology is not supposed to guide the process but to support it
  - The choice of technology(ies) must be based on clearly defined needs
- ➡ Choosing the technology(ies) is not the starting point of the process
- And above all,...Garbage in – Garbage out!

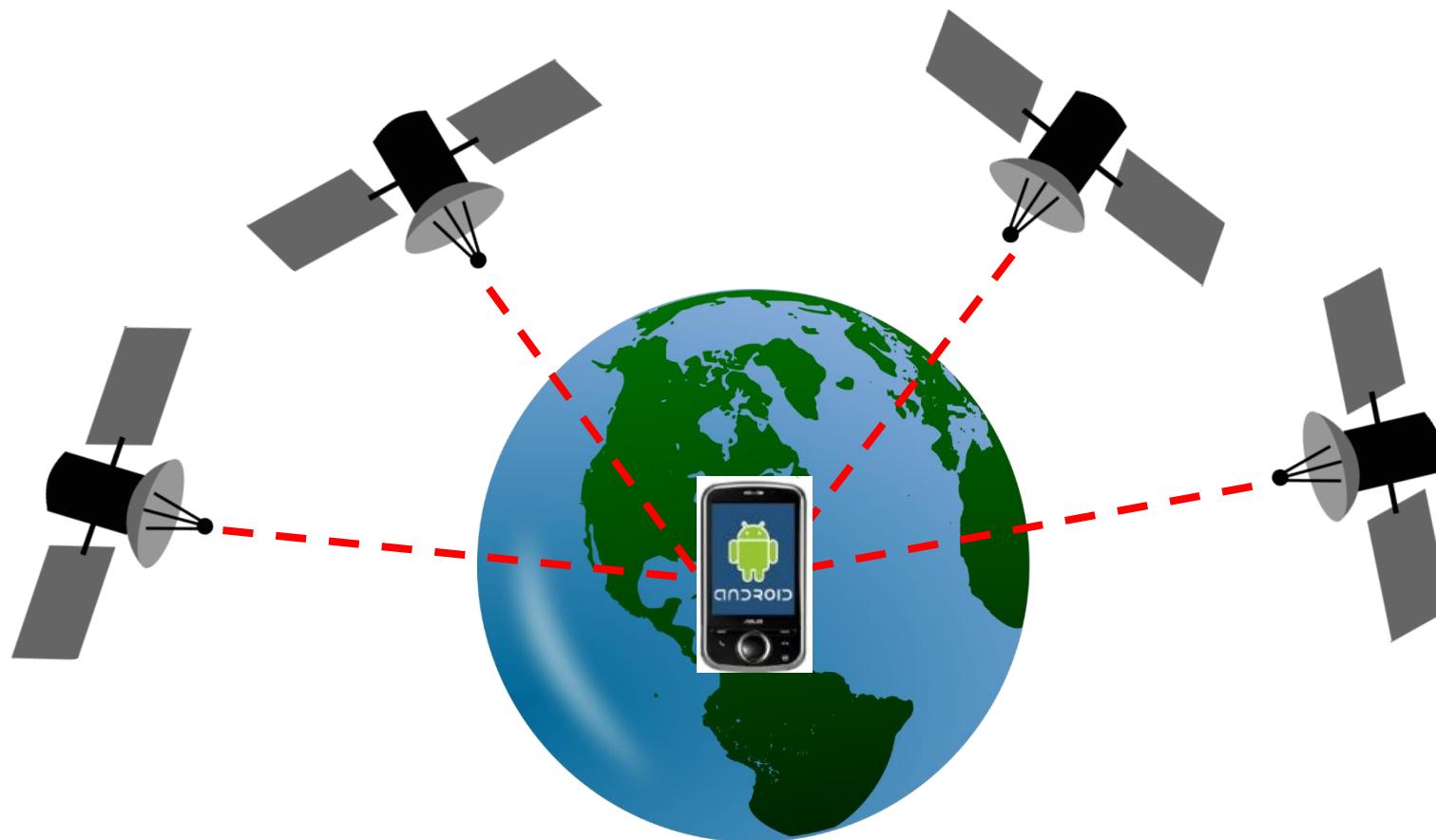
# Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

*...and beyond*

Session 17: Introduction to Global Navigation Satellite System (GNSS)

# Global Navigation Satellite System (GNSS)

Constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers. The receivers then use this data to determine its location.



# Global Navigation Satellite Systems (GNSS)

There are currently four different satellite navigation systems providing autonomous geospatial positioning:

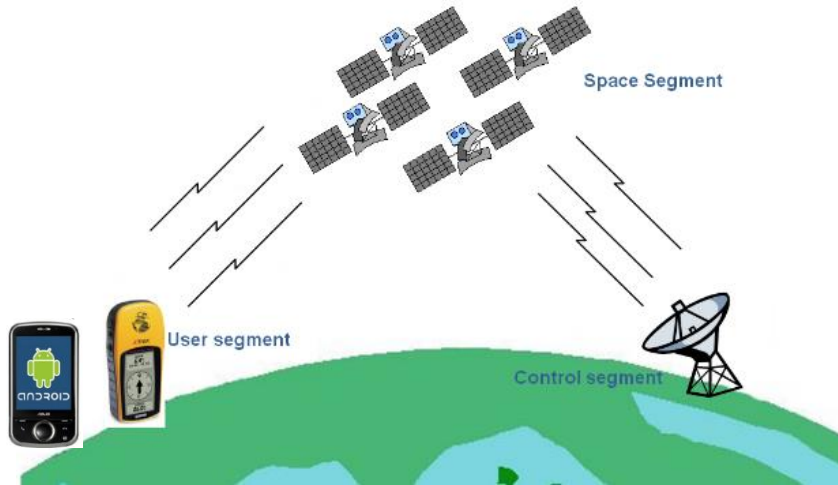
**GPS (USA), GLONASS (Russia), BeiDou (China), and Galileo (EU).**



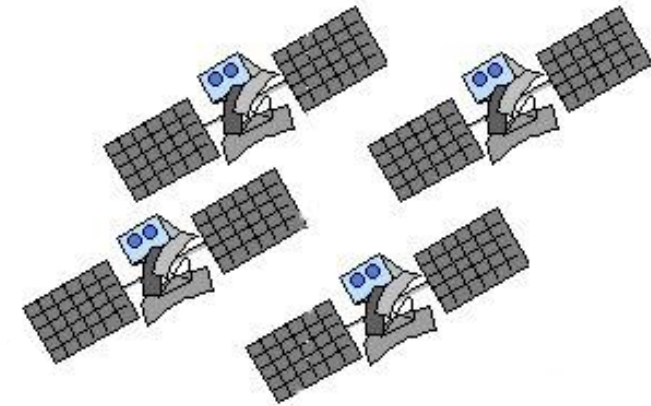
| System               | GPS   | GLONASS  | BeiDou  | Galileo  |
|----------------------|---|--|---|--|
| Owner                | United States                                     | Russian Federation   | China   | European Union   |
| Orbital altitude     | 20, 180 km (12, 540 mi)                           | 19, 130 km, (11, 890 mi)   | 21, 150 km, (13, 140 mi)  | 23,222 km, (14, 429 mi)  |
| Period               | 11.97 h, (11 h 58 min)                            | 11.26 h, (11 h 16 min)   | 12.63 h, (12 h 38 min)  | 14.08 h, (14h 5min)  |
| Number of satellites | 32 (at least 24 by design)                        | 28 (at least 24 by design) including: 24 operational 2 under check by the satellite prime contractor 2 in flight tests phase | 5 geostationary orbit (GEO) satellites, 30 medium Earth orbit (MEO) satellites  | 4 in-orbit validation satellites + 8 full operation capable satellites in orbit 22 operational satellites budgeted |
| Frequency            | 1.57542 GHz (L1 signal)<br>1.2276 GHz (L2 signal) | Around 1.602 GHz (SP)<br>Around 1.246 GHz (SP)   | 1.561098 GHz (B1)<br>1.589742GHz (B1-2)<br>1.20714 GHz (B2)<br>1.26852 GHz (B3) | 1.164-1.215 GHz (E5a and E5b)<br>1.260-1.300 GHz (E6)<br>1.559-1.592 GHz (E2-L1-E11)                               |
| Status               | Operational                                       | Operational  | 22 satellites operational, 40 additional satellites 2016-2010                   | 8 satellites operational, 22 additional satellites 2016-2020   |



# GNSS – How it works



No need for internet!!!

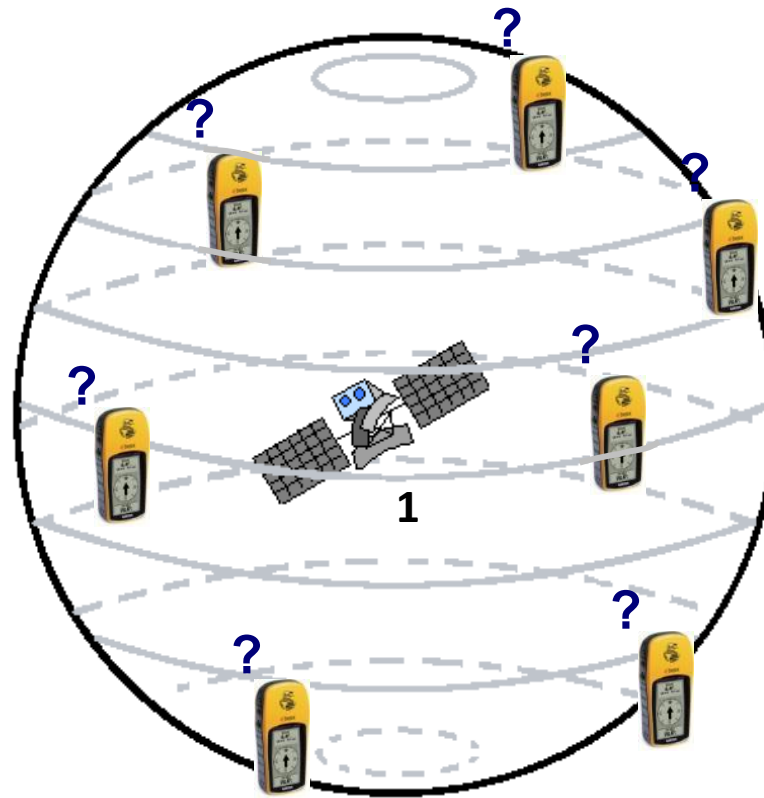


The signal received from each satellite contains:

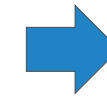
1. Satellite unique identifier
2. Almanac data (state and orbital information to calculate which satellites are visible)
3. Ephemeris data (precise orbital information to calculate satellite location)

# GNSS – How it works

When receiving the signal from only one satellite



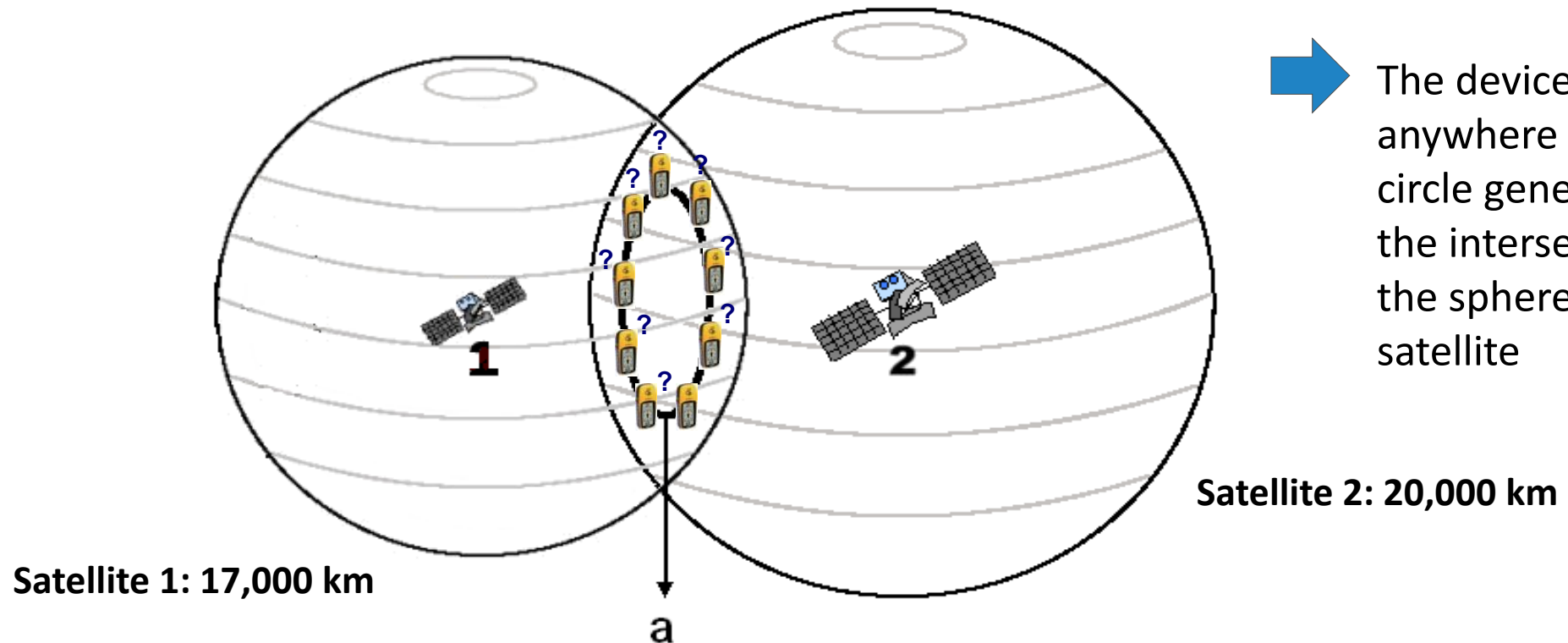
Satellite 1: 17,000 km



The device can be anywhere of a sphere with a radius equal to the distance measured between the satellite and the device

# GNSS – How it works

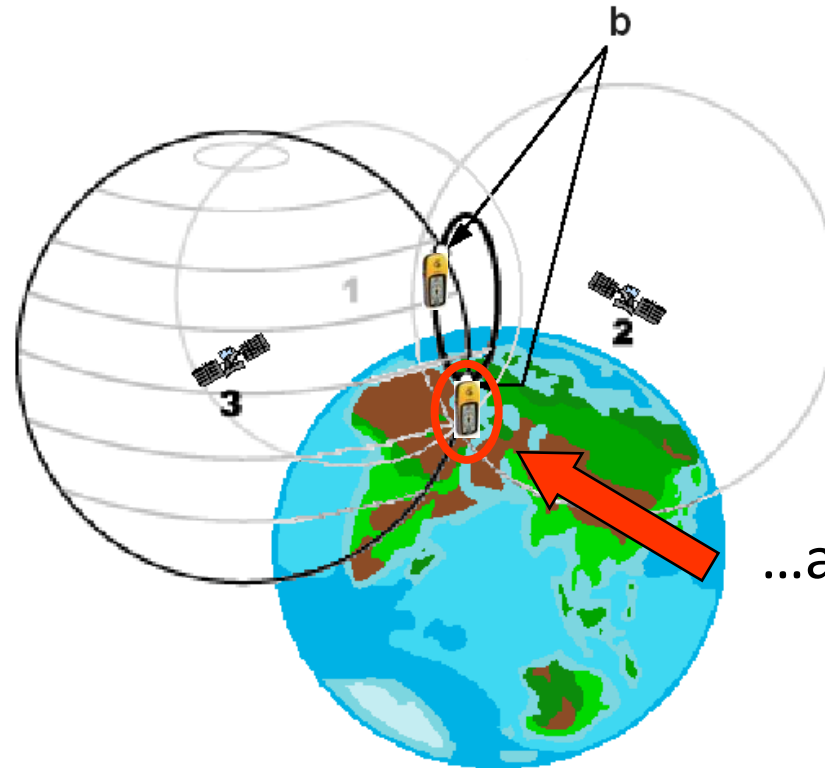
When receiving the signal from only one satellite



# GNSS – How it works

As soon as you receive the signal from 3 satellites...

➔ Intersection between the circle and one more sphere => 2 points



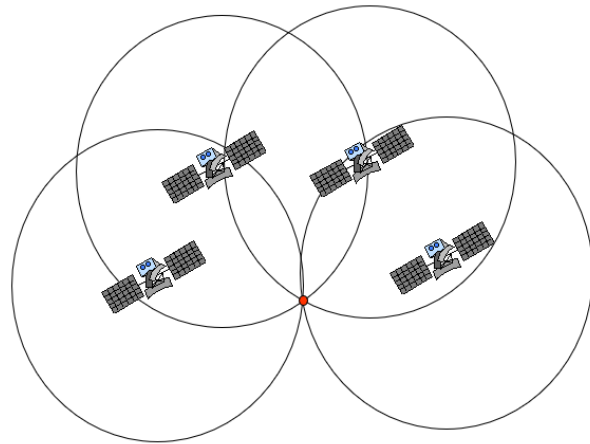
...and with 4 signals ➔ Only 1 point possible

- ➔ Reason why you need at least 4 satellite signals to get a good reading
- ➔ Facilitated by the existence of the 4 constellations (if your device can receive their signal)

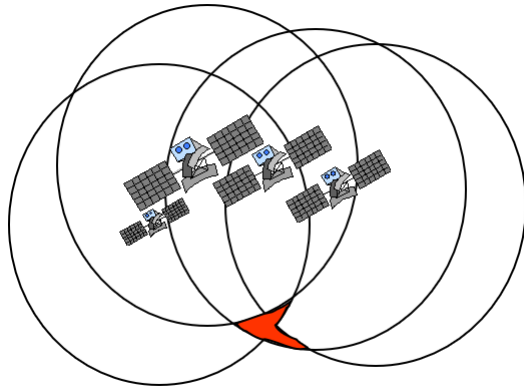
# GNSS - Source of signal errors

Another thing which is facilitated by the existence of the 4 constellations

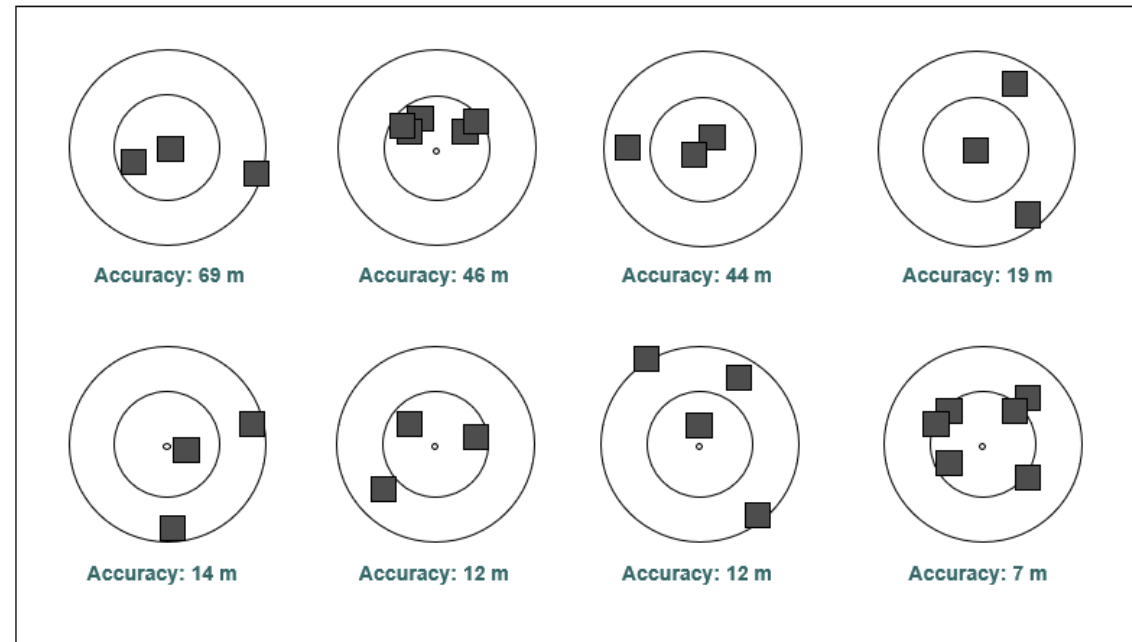
Positional Dilution of Precision (PDOP)



Good PDOP



Poor PDOP

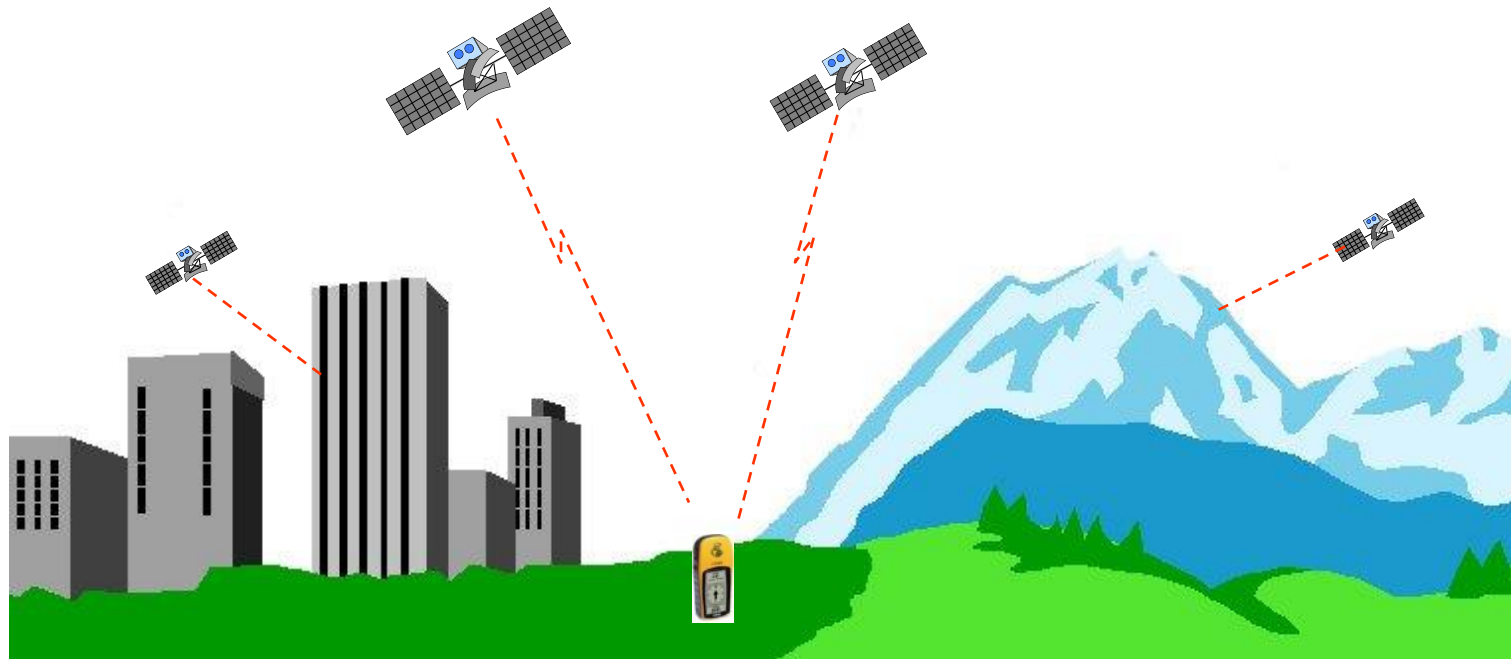


It is preferable to have a good dispersion and to look at the accuracy measurement given by the device



# GNSS - Source of signal errors

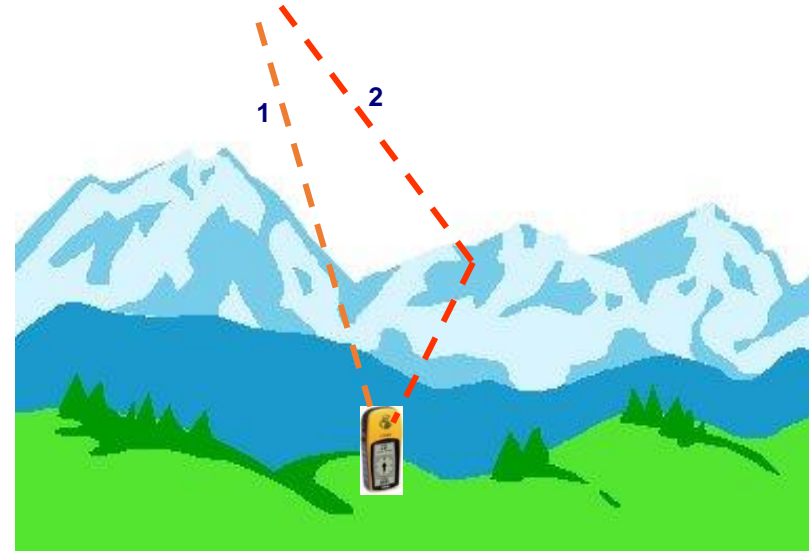
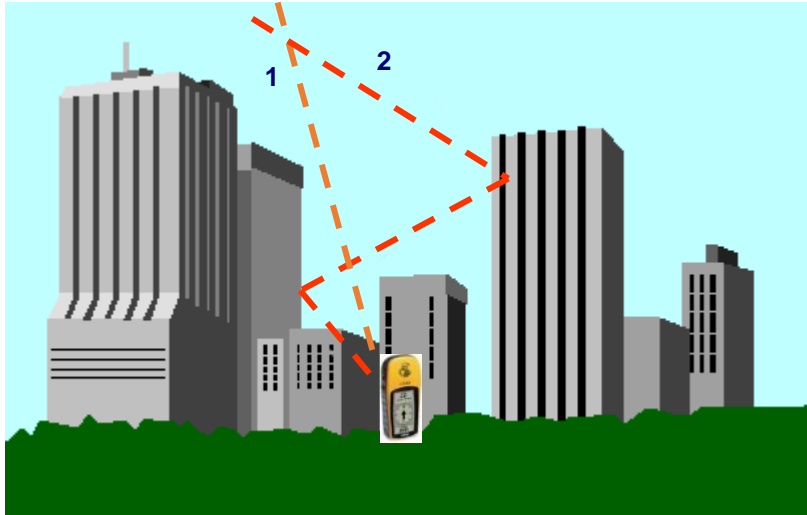
Natural or artificial barriers



➔ Important to be in the most open space possible when collecting geographic coordinates

# GNSS - Source of signal errors

## Signal multipath



➡ Important to be in the most open space possible when collecting geographic coordinates

# GNSS - Devices



➡ Large selection / Different prices!

Minimum requirements:

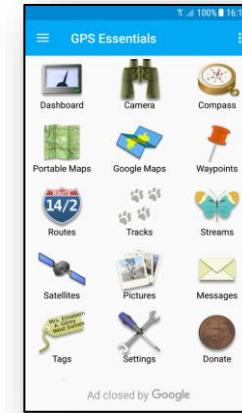
1. Allows to be configured as follows:
  - a. Position format (decimal degrees: hddd.ddddd)
  - b. Map datum/Cartographic reference system: WGS84
  - c. Map spheroid: WGS84
  - d. Distance and speed: Meter
2. Provide a reading with at least 5 decimal places to reach a level of precision down to the meter
3. Display the following information:
  - a. Number of satellite signals received
  - b. Accuracy measure
4. Having access to GPS and GLONASS constellations (Also having access to Galileo and Bei Dou is a big plus)

➡ A smart phone with a good GNSS receiver and an app is the option being used the most frequently nowadays

# GNSS Apps for smart phones (Android, iPhone)

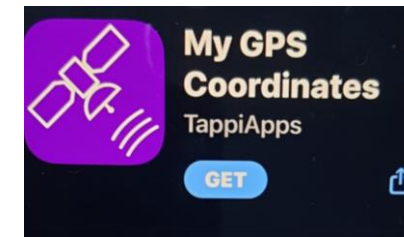
## Android

GPS Essentials is a free app available for Android devices with a built-in GNSS receiver that complies with all the recommended requirements



## iPhone

“My GPS coordinates” is a free app available for Apple devices (iPhone/iPad)



➔ These app can be used as an alternative to dedicated GNSS-enabled devices when collecting geographic coordinates as it complies with the specifications discussed in previous slides.



# GNSS - Unit setting

|   |
|---|
| Distance and Speed<br><b>Metric</b>                 |
| Elevation ( Vertical Speed)<br><b>Metric(m/min)</b> |

|                                      |
|--------------------------------------|
| Position Format<br><b>hddd.ddddd</b> |
| Map Datum<br><b>WGS84</b>            |
| Map Spheroid<br><b>WGS 84</b>        |

**Must match the data specifications**

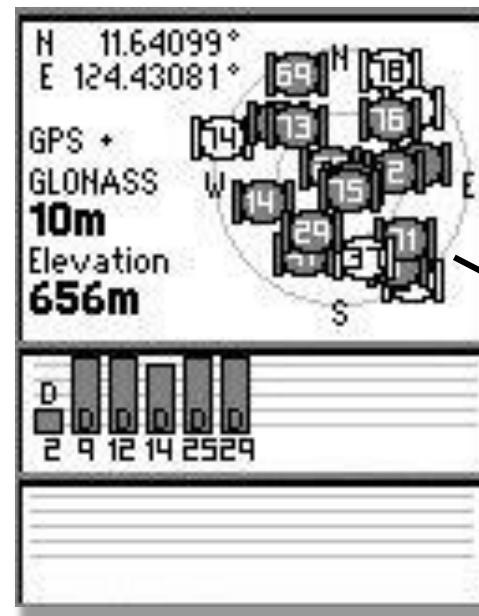
Taking a reading

Coordinates

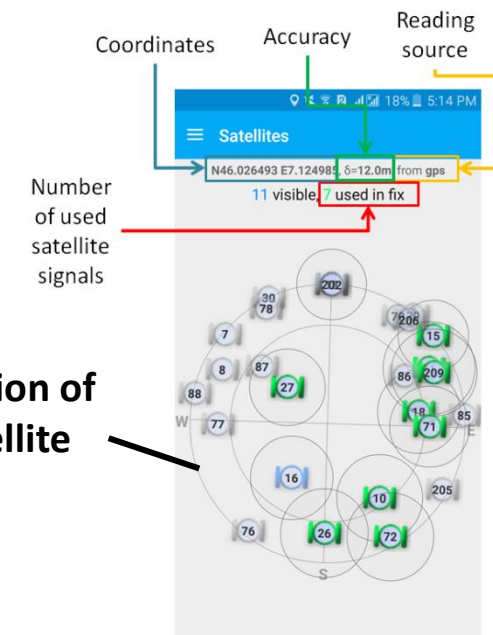
GPS and GLONASS activated

Accuracy value

Number of satellite signals received



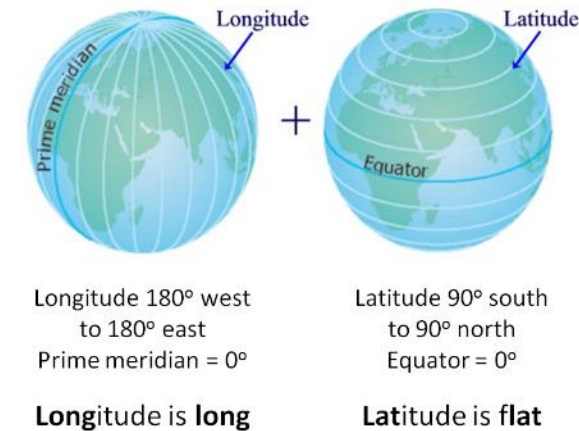
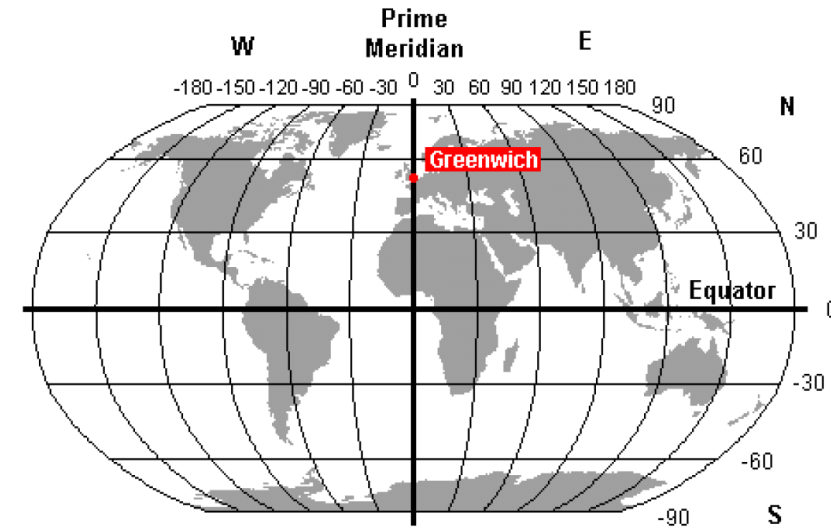
GNSS device



Mobile phone + app

# GNSS - Why using decimal degrees (latitude and longitude)?

- Easiest georeferencing method to use
  - Standardized, stable, unique, infinitely fine resolution
- Uses a well-defined and fixed frame of reference
  - Based on the Greenwich (Prime) Meridian and the Equator
- Most used in geospatial technologies
  - Can be easily projected if needed



# GNSS - Scale, accuracy and precision

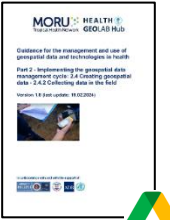
| Classification | Map examples                            | Range examples              | Expected positional accuracy (m) |
|----------------|---|-----------------------------|----------------------------------|
| Large scale    | Village, town or sub national level map | 1:1 - 1:10,000              | 0 - 8                            |
|                |   | 1:50,000 - 1:100,000        | 26 - 52                          |
|                |   | 1:250,000 - 1:500,000       | 130 - 259                        |
| Medium scale   | Country map                             | 1:750,000 - 1:1,000,000     | 389 - 518                        |
|                |   | 1:1,500,000 - 1:2,000,000   | 777 - 1,036                      |
| Small scale    | World map                               | 1:5,000,000 - 1:10,000,000  | 2,591 - 5,182                    |
|                |   | 1:25,000,000 - 1:50,000,000 | 12,954 - 25,908                  |



**Recommended**

| Number of captured digits | Example (Longitude) | Maximum potential error (m) | Precision level |
|---------------------------|---------------------|-----------------------------|-----------------|
| 1                         | 120.9               | 11,132                      |                 |
| 2                         | 120.93              | 1,113                       | Kilometre       |
| 3                         | 120.037             | 111                         | Hectometre      |
| 4                         | 120.9376            | 11                          | Decametre       |
| 5                         | 120.93761           | 1                           | Metre           |

# GNSS - Data collection methods



| <div>Needs</div> <div>Scalability</div> | Main data use:<br>visualization   | Main data use: Geographic component of a point type registry,<br>visualization, spatial analysis and spatial modeling |   |   |
|---|---|---|---|---|
|   | Accuracy: low to<br>moderate  | Accuracy: moderate to<br>high   | Accuracy: high  |   |
| High                                    | 1. Paper form + device<br>without GNSS + offline<br>map application   |   |   |   |
| Moderate to low                         | 2. Paper form + device<br>without GNSS + offline<br>map application +<br>min/max lat/long annex                 | 4. Paper form + GNSS<br>enabled device with<br>accuracy indicators  | 7. Paper form + GNSS<br>enabled device with<br>accuracy indicators +<br>min/max lat/long annex<br>or offline map<br>application                                     | 10. Paper form + GNSS<br>enabled device with<br>accuracy indicators +<br>min/max lat/long annex<br>+ offline map<br>application                                     |
|   | 3. Electronic form<br>(table) + device without<br>GNSS + offline map<br>application + min/max<br>lat/long annex | 5. Electronic form<br>(table) + GNSS enabled<br>device with accuracy<br>indicators                                    | 8. Electornic form<br>(table)+ GNSS enabled<br>device with accuracy<br>indicators + min/max<br>lat/long annex or<br>offline map application                         | 11. Electronic form<br>(table) + GNSS enabled<br>device with accuracy<br>indicators + min/max<br>lat/long annex + offline<br>map application                        |
| Low                                     |   | 6. Data collection<br>application integrated<br>in the GNSS enabled<br>device with accuracy<br>indicators             | 9. Data collection<br>application integrated<br>in the GNSS enabled<br>device with accuracy<br>indicators + min/max<br>lat/long annex or<br>offline map application | 12. Data collection<br>application integrated<br>in the GNSS enabled<br>device with accuracy<br>indicators + min/max<br>lat/long annex + offline<br>map application |

Without GNSS-enabled device

With GNSS-enabled device

[https://www.healthgeolab.net/DOCUMENTS/Guide\\_HGLC\\_Part2\\_4\\_2.pdf](https://www.healthgeolab.net/DOCUMENTS/Guide_HGLC_Part2_4_2.pdf)



# GNSS - Standard Operating Procedure (SOP)

It is important to have and follow a Standard Operating Procedure (SOP)

The SOP should at least cover:

1. Description of the device being used
2. Device and/or app user manual (buttons, functions, etc.)
3. How to configure the device and/or app
4. Material to use in addition to the device and/or app (e.g. form, other documents)
5. Step-by-step process for data collectors

**Annex 6 – Short user manual for the Garmin eTrex device**

**A6.1 - Device overview**

Figure 5.1 shows the different parts of the Garmin eTrex GPS device. These parts are identical for all the models in Table 1.

**Figure 5.1 - Parts of the Garmin eTrex GPS device**

The buttons on the device are operated as follows:

- Move the Thumb Stick up, down, move around the map.
- Press the centre of the Thumb Stick to zoom in.
- Press back to move back one step.
- Press menu to display a list of options.
- Press  $\Delta$  and  $\nabla$  to zoom in and out.

**A6.2 - Installing the batteries**


The eTrex GPS device takes two AA batteries. Here are the steps to install them:

- Turn the D-ring counter-clockwise (to the left) and pull to remove the battery cover.
- Insert the batteries, making sure they are oriented correctly for polarity.
- Replace the battery cover, and turn the D-ring clockwise (to the right).
- Press and hold the On/Off button.
- Select "Setup > System > Battery Type".

Select Alkaline, Lithium or Rechargeable NiMH as appropriate.

| Step      | Action   |          |                               |                        |    |                        |                             |           |      |     |    |
|-----------|--|----------|-------------------------------|------------------------|----|------------------------|-----------------------------|-----------|------|-----|----|
| 3.1       | Once you have arrived at the place to be located, find an open area, turn the GPS option of your Android device on and open the GPS Essentials application.  |          |                               |                        |    |                        |                             |           |      |     |    |
| 3.2       | Go to the "Settings" page using the device. Go to the "Units" page and set the units to Meters (SI). Position datum => World Geodetic System 1984 (WGS 84). Position format => Decimal.  |          |                               |                        |    |                        |                             |           |      |     |    |
| 14.       | Move to the front of the household.  |          |                               |                        |    |                        |                             |           |      |     |    |
| 15.       | Wait for the accuracy value to become lower than 15 meters with at least 4 satellite signals received. A good practice would be to stay around one minute on the same spot to allow for the best reading possible.<br><br>In the example presented on the side here, the accuracy is 10 m with 6 satellite signals received (out of 48 as we have both the GPS and GLONASS satellite system on). |          |                               |                        |    |                        |                             |           |      |     |    |
| 16.       | Once the accuracy value is below 15 meters with at least 4 satellite signals, write down the number of satellite signals and accuracy in fields A5 and A6 of the questionnaire as presented here:<br><table border="1"><tr><td>A5</td><td>GPS: No. of Satellite signals</td><td>6</td><td>A6</td><td>GPS: Accuracy (meters)</td><td>10</td></tr></table>   | A5       | GPS: No. of Satellite signals | 6                      | A6 | GPS: Accuracy (meters) | 10                          |           |      |     |    |
| A5        | GPS: No. of Satellite signals  | 6        | A6                            | GPS: Accuracy (meters) | 10 |                        |                             |           |      |     |    |
| 17.       | Mark the waypoint by pressing and holding the thumb stick. You will be brought to the "Mark Waypoint" page as seen here:<br><table border="1"><tr><td colspan="2">TRANSoft</td></tr><tr><td colspan="2">Name</td></tr><tr><td>Location</td><td>N 11.64099°<br/>E 124.43081°</td></tr><tr><td>Elevation</td><td>656m</td></tr><tr><td>Map</td><td>Go</td></tr></table>                            | TRANSoft |                               | Name                   |    | Location               | N 11.64099°<br>E 124.43081° | Elevation | 656m | Map | Go |
| TRANSoft  |  |          |                               |                        |    |                        |                             |           |      |     |    |
| Name      |  |          |                               |                        |    |                        |                             |           |      |     |    |
| Location  | N 11.64099°<br>E 124.43081°  |          |                               |                        |    |                        |                             |           |      |     |    |
| Elevation | 656m   |          |                               |                        |    |                        |                             |           |      |     |    |
| Map       | Go   |          |                               |                        |    |                        |                             |           |      |     |    |

It is also important to have an SOP for the supervisors



# GNSS – Before data collection

This phase is critical for the data collectors to be independent in the field and able to collect high quality geographic coordinates with minimal supervision

Two primary actions:

1. Prepare the material needed to implement the selected data collection method
2. Select and train the data collectors and their supervisor(s)



## SECTION 1 NAME AND CODE OF THE GEOGRAPHIC OBJECT AS PER THE MASTER LIST

|   |   |
|---|---|
| 1a. Name of the geographic object as per the master list  |   |
| 1b. Code of the geographic object as per the master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

## SECTION 2 ADDRESS AND LOCATION OF THE GEOGRAPHIC OBJECT

|  |   |
|--|---|
| 2a. Street name and number   |   |
| 2b. Postal code  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>   |
| 2c. Name of the 1st level administrative division as per the official master list: |   |
| 2d. Name of the 2nd level administrative division as per the official master list: |   |
| 2e. Name of the 3rd level administrative division as per the official master list: |   |
| 2f. Name of the ... level administrative division as per the official master list: |   |
| 2g. Code of the ... level administrative division as per the official master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

## SECTION 3 GEOGRAPHIC COORDINATES OF THE GEOGRAPHIC OBJECT

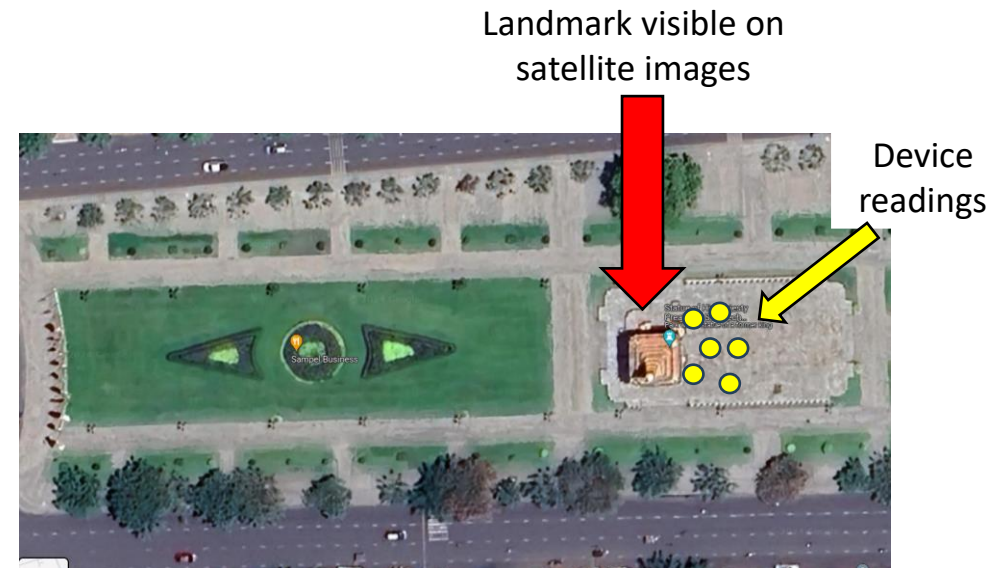
|  |   |   |
|--|---|---|
| 3a. Location of the geographic object visible on the map             | <input type="text"/> <input type="text"/> | No (clouds, blurry image, no features in the area.) |
| 3b. Scale at the time of taking the coordinates (maximum: 50 meters) | <input type="text"/> <input type="text"/> | meters  |



# GNSS – Before data collection (material preparation)

The preparation of the material must cover the:

1. Selection of the collection method that will be implemented
2. Adjustment of the data collection form to match the selected method
3. Creation of the electronic form, if required
4. Preparation of the associated documents and material
5. Development of the SOP to be implemented in the field
6. Installation of the applications on the devices if required
7. Configuration of the devices and/or app and verification that the GNSS receiver is working correctly
8. Preparation of the training material



GNSS receiver working correctly



Potential issues with the GNSS receiver

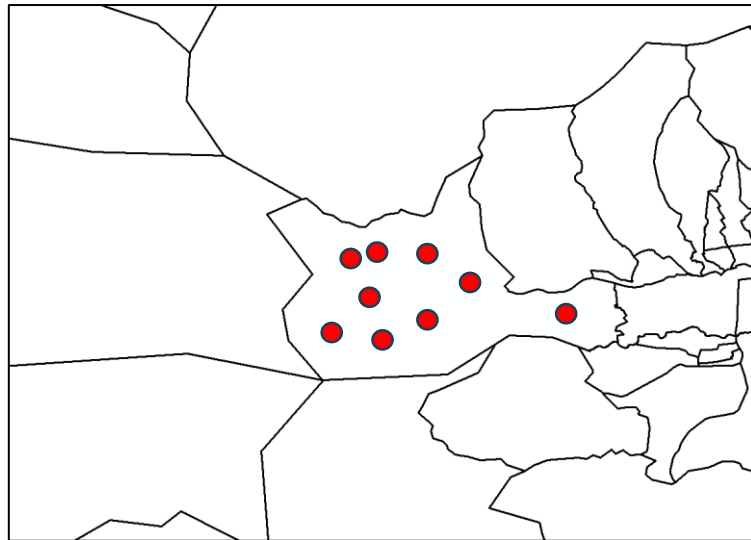


# GNSS – Before data collection (selection and training of collectors)

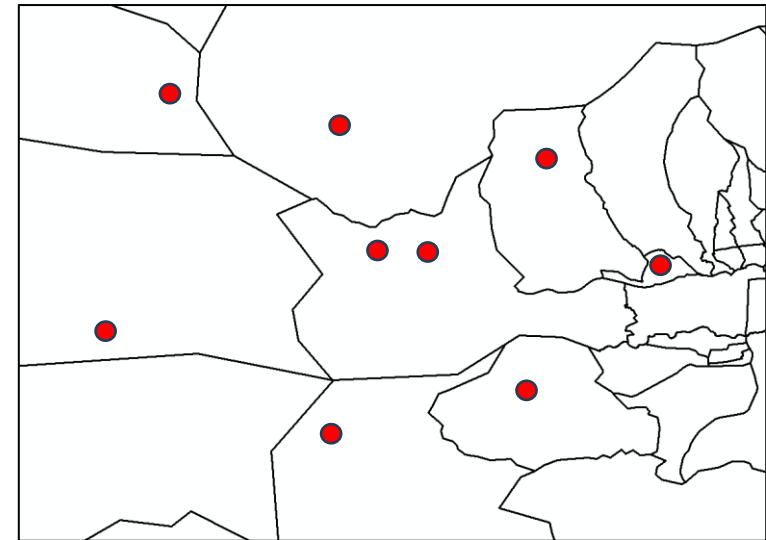
Knowledge and experience in using GNSS-enabled devices should be considered when selecting data collectors and their supervisor(s).

In addition to selecting qualified data collectors, training data collectors and their supervisor(s) is one of the, if not the most, important steps in the pre-survey process.

This is what will make the difference between...



...this...



..and this



# GNSS – Before data collection (training)

The training should aim to provide a good understanding and proper use of the different documents, the data collection equipment, and SOPs. The training should also cover appropriate troubleshooting methods regarding commonly encountered issues while in the field

To achieve these goals, the training should at least cover the following topics:

1. Overview of existing GNSS and use of the chosen GNSS-enabled device
2. Introduction to the GNSS-enabled device
3. SOP to complete the data collection instrument
4. Hands-on practice session

It is important to:

- Allocate enough time for the above-mentioned session.
- Ensure that the participants can ask questions.
- Give copies of the different documents to all the participants.
- Ensure every participant has the opportunity for hands-on practice of using a GNSS-enabled device.
- Check all the GNSS-enabled devices to be used in the field if not already done

# GNSS – During data collection

During the field data collection exercise, the data collectors should follow the SOP using the associated documents that have been provided to them.

Despite a high-quality training session, it remains important to verify the methods used to collect the geographic location information and address any unexpected issues while the data collectors are in the field.

The following verification steps should be followed depending on available resources and the extent of the surveyed area:

1. On-site spot checks of data accuracy and completeness conducted by the data collection supervisor. Part of the check for accuracy can be performed using Survey123 for ArcGIS, Maps.Me, or Google Maps as way to ensure that the point is falling in the expected area.
2. Verification of the data remotely through periodic submissions of the collected data in a spreadsheet, either using Google Sheets online or emailing a Microsoft Excel spreadsheet to the data collection supervisor. For certain applications, a purpose-designed online database system may be used as well. However, these solutions usually require a regular access to the internet.

# GNSS – After data collection

Ensure that the collected data is organized in a structured table that can be saved as a spreadsheet (e.g. in Microsoft Excel) and should contain all the fields that are on the data collection form

| HF_Name                          | HF_Code | Address          | Pos_Code | Reg_name   | Prov_name | Mun_name     | Bgy_name             | Bgy_code    | Nbr_Sat | Accuracy | Wtin_box | Wtin_map | Latitude | Longitude | Waypoint | Comments                                       | Op_Name         | Dev_brand       | Dev_ser  | Coll_date |
|----------------------------------|---------|------------------|----------|------------|-----------|--------------|----------------------|-------------|---------|----------|----------|----------|----------|-----------|----------|--|-----------------|-----------------|----------|-----------|
| SANTANDER RURAL HEALTH UNIT      | 903     | NATIONAL ROAD    | 6026     | REGION VII | CEBU      | SANTANDER    | POBLACION            | PH072245008 | 10      | 9.3      | Yes      | Yes      | 9.41705  | 123.3349  | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| ALCANTARA RURAL HEALTH UNIT      | 1399    | NA               | 6033     | REGION VII | CEBU      | ALCANTARA    | POBLACION            | PH072201007 | 10      | 10.5     | Yes      | Yes      | 9.97036  | 123.4024  | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| ALCOY RURAL HEALTH UNIT          | 1437    | NATIONAL HIGHWAY | 6023     | REGION VII | CEBU      | ALCOY        | POBLACION            | PH072202006 | 11      | 10.1     | Yes      | Yes      | 9.70925  | 123.50729 | 2        | Reading taken 10 meters away from the facility | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| BALIRI RURAL HEALTH UNIT         | 1454    | NA               | 6036     | REGION VII | CEBU      | BARILI       | POBLACION            | PH072210038 | 9       | 10.0     | Yes      | Yes      | 10.11565 | 123.50997 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| BORBON RURAL HEALTH UNIT         | 1458    | NA               | 6008     | REGION VII | CEBU      | BORBON       | POBLACION            | PH072213015 | 10      | 10.3     | Yes      | Yes      | 10.88766 | 124.02753 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| MINGLANILLA RURAL HEALTH UNIT I  | 1465    | NA               | 6046     | REGION VII | CEBU      | MINGLANILLA  | POBLACION WARD IV    | PH072232013 | 10      | 10.1     | Yes      | Yes      | 10.24579 | 123.79552 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| MINGLANILLA RURAL HEALTH UNIT II | 1897    | LIPATA STREET    | 6046     | REGION VII | CEBU      | MINGLANILLA  | LINAO                | PH072232007 | 10      | 10.3     | Yes      | Yes      | 10.25576 | 123.80998 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| RONDA RURAL HEALTH UNIT          | 1983    | NA               | 6034     | REGION VII | CEBU      | RONDA        | POBLACION            | PH072239011 | 10      | 10.4     | Yes      | Yes      | 10.00051 | 123.40961 | 2        | Reading taken on the nearby parking            | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| SAMBOAN RURAL HEALTH UNIT        | 2032    | NA               | 6027     | REGION VII | CEBU      | SAMBOAN      | POBLACION            | PH072240011 | 11      | 10.0     | Yes      | Yes      | 9.52916  | 123.30664 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| CONSOLACION RURAL HEALTH UNIT    | 2890    | NA               | 6001     | REGION VII | CEBU      | CONSOLACION  | POBLACION OCCIDENTAL | PH072219013 | 10      | 10.2     | Yes      | Yes      | 10.37651 | 123.95548 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| BADIAN RURAL HEALTH UNIT         | 2971    | NA               | 6031     | REGION VII | CEBU      | BADIAN       | POBLACION            | PH072207020 | 10      | 10.4     | Yes      | Yes      | 9.86547  | 123.39327 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| MENDELLIN RURAL HEALTH UNIT      | 3245    | NA               | 6012     | REGION VII | CEBU      | MEDELLIN     | POBLACION            | PH072231014 | 10      | 9.7      | Yes      | Yes      | 11.13814 | 123.96175 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| SAN REMEGIO RURAL HEALTH UNIT    | 3830    | NA               | 6011     | REGION VII | CEBU      | SAN REMIGIO  | POBLACION            | PH072243020 | 9       | 9.5      | Yes      | Yes      | 11.0844  | 123.93526 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| SOGOD RURAL HEALTH UNIT          | 3846    | NA               | 6007     | REGION VII | CEBU      | SOGOD        | POBLACION            | PH072247016 | 10      | 8.0      | Yes      | Yes      | 10.74711 | 124.00234 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| MALABUYOC RURAL HEALTH UNIT      | 4618    | NA               | 6029     | REGION VII | CEBU      | MALABUYOC    | BARANGAY I (POB.)    | PH072229015 | 9       | 10.2     | Yes      | Yes      | 9.65667  | 123.32608 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| TABOGON RURAL HEALTH UNIT        | 4662    | NA               | 6009     | REGION VII | CEBU      | TABOGON      | POBLACION            | PH072248018 | 7       | 7.9      | Yes      | Yes      | 10.93972 | 124.02554 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| OSLOB RURAL HEALTH UNIT          | 4734    | SAN JOSE STREET  | 6025     | REGION VII | CEBU      | OSLOB        | POBLACION            | PH072235020 | 10      | 9.7      | Yes      | Yes      | 9.52043  | 123.43307 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| TABUELAN RURAL HEALTH UNIT       | 4902    | NA               | 6044     | REGION VII | CEBU      | TABUELAN     | POBLACION            | PH072249016 | 9       | 10.6     | Yes      | Yes      | 10.82051 | 123.86578 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| SIBONGA RURAL HEALTH UNIT        | 4953    | NA               | 6020     | REGION VII | CEBU      | SIBONGA      | POBLACION            | PH072246021 | 10      | 10.3     | Yes      | Yes      | 10.0168  | 123.62104 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| DAANBANTAYAN RURAL HEALTH UNIT I | 5321    | NA               | 6013     | REGION VII | CEBU      | DAANBANTAYAN | POBLACION            | PH072221016 | 11      | 9.9      | Yes      | Yes      | 11.25073 | 123.99672 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| CATMON RURAL HEALTH UNIT         | 5776    | NA               | 6006     | REGION VII | CEBU      | CATMON       | POBLACION            | PH072216019 | 11      | 9.9      | Yes      | Yes      | 10.72265 | 124.01185 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| DUMANJUG RURAL HEALTH UNIT       | 6660    | NA               | 6035     | REGION VII | CEBU      | DUMANJUG     | POBLACION            | PH072224039 | 11      | 10.4     | Yes      | Yes      | 10.05895 | 123.43551 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| BOLIJOON RURAL HEALTH UNIT       | 7249    | NATIONAL HIGHWAY | 6024     | REGION VII | CEBU      | BOLIJOON     | POBLACION            | PH072212005 | 10      | 10.3     | Yes      | Yes      | 9.62875  | 123.47986 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| CARMEN RURAL HEALTH UNIT         | 7262    | NA               | 6005     | REGION VII | CEBU      | CARMEN       | POBLACION            | PH072215016 | 9       | 9.9      | Yes      | Yes      | 10.58881 | 124.0162  | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| GINATILAN RURAL HEALTH UNIT      | 7668    | NA               | 6028     | REGION VII | CEBU      | GINATILAN    | POBLACION            | PH072225012 | 10      | 10.2     | Yes      | Yes      | 9.56988  | 123.312   | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| MOALBOAL RURAL HEALTH UNIT       | 7669    | NA               | 6032     | REGION VII | CEBU      | MOALBOAL     | POBLACION EAST       | PH072223010 | 11      | 10.5     | Yes      | Yes      | 9.9364   | 123.39281 | 1        | None   | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12  |
| ALEGRIA RURAL HEALTH UNIT        | 7670    | NA               | 6030     | REGION VII | CEBU      | ALEGRIA      | POBLACION            | PH072203007 | 9       | 10.0     | Yes      | Yes      | 9.72951  | 123.33949 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |
| MALINGIN BARANGAY HEALTH STATION | 15099   | NA               | 6013     | REGION VII | CEBU      | DAANBANTAYAN | MALINGIN             | PH072221012 | 11      | 9.9      | Yes      | Yes      | 11.219   | 124.01289 | 1        | None   | Daniel Durand   | Garmin eTrex 30 | 30E00828 | 10-12-12  |

➡ Don't forget about the data catalogue and metadata worksheets covered during Session 14

# GNSS - Summary

- Choose the appropriate GNSS-enabled device (check the quality of the GNSS receiver) and data collection method
- Use a pre-established Standard Operating Procedure (SOP) which includes all the necessary information for the data collectors to properly collect coordinates in the field (e.g. source of error signals) as well as a SOP for the supervisors
- Collect high accuracy (instrumental accuracy below 15 meters) and high precision (5 digits after the decimal point) coordinates
- Invest in a good training for data collectors and supervisors
- Establish a good monitoring process during data collection
- Properly store and document the geographic coordinates resulting from the data collection exercise

Note: Pay attention to potential ethical issues when locating or tracking individuals with a high accuracy !!!



# Short break



# Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

*...and beyond*

## Session 18: Introduction to Geographic Information System (GIS)

# Geographic Information Systems (GIS)

## Two types of definitions

“A **computer system** that analyzes and displays geographically referenced information”

“**Computer tool** for representing and analyzing all the things that exist on earth as well as all the events that occur there”

➡ GIS as a geospatial technology- software

“**Information system** designed to collect, store, process, analyze, manage, and present all types of spatial and geographic data”

“**Information system** set up by an organization to describe the spatial objects, phenomena, and processes that are necessary for its action “

➡ GIS as an information system

➡ Often a source of confusion

# GIS as a software

## Desktop GIS software:

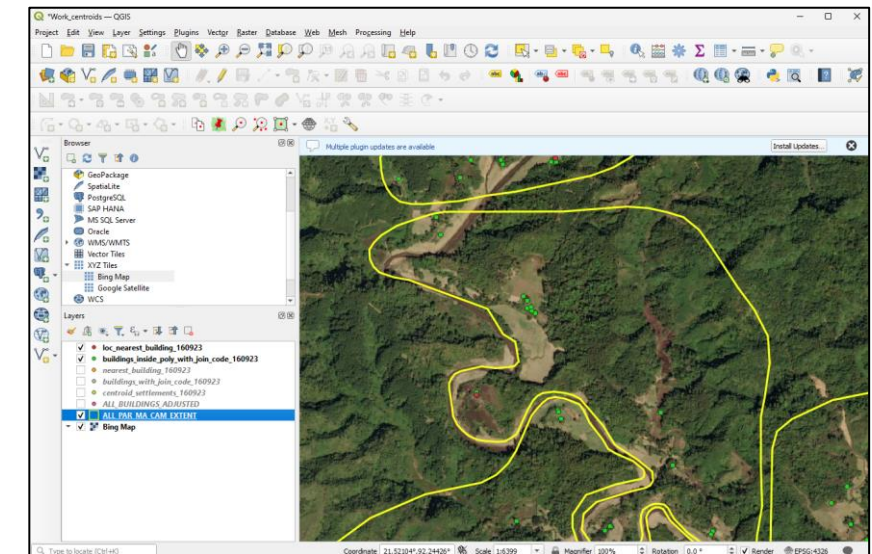
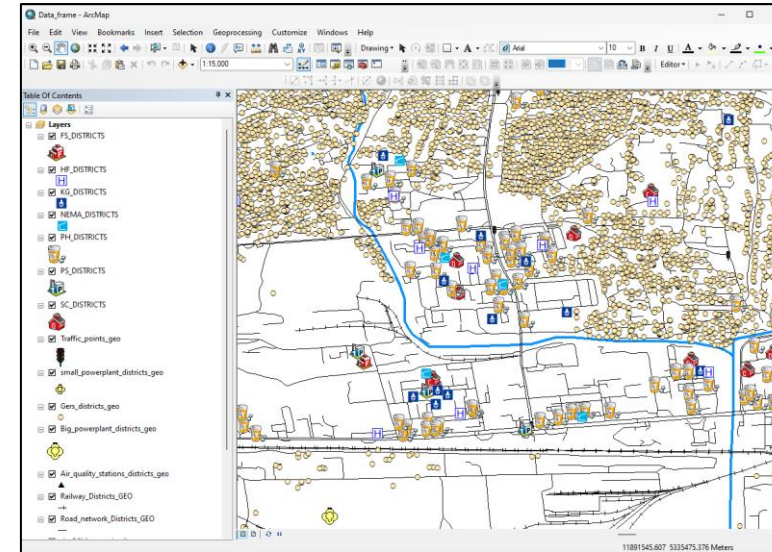
- Most used type of tool and providing the widest number of features. The most used being QGIS and ArcMap/ArcGIS Pro

## Online GIS application:

- Not as fast nor offering as many features as desktop GIS programs but still providing much of the same functionality (examples: ArcGIS Online (proprietary) or GeoNode (open source))
- Can provide a convenient bridge between desktop work and a mobile work environment
- Deployed either on the cloud or on a local server, each of which has a cost

## GIS extensions:

- Additional tools that are required to operationalize certain applications and/or not available by default in desktop or online GIS software
- Available as extensions (example: ArcGIS Spatial Analyst Extension)

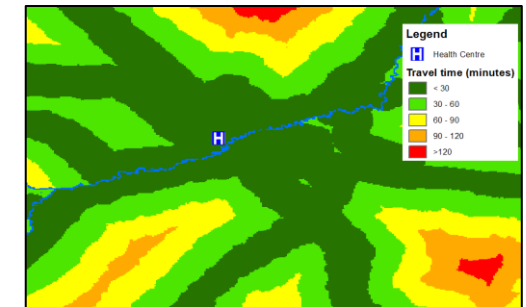
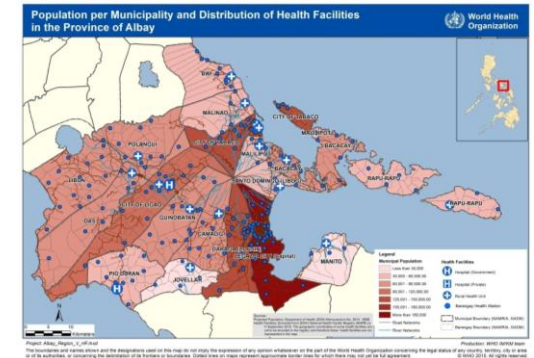
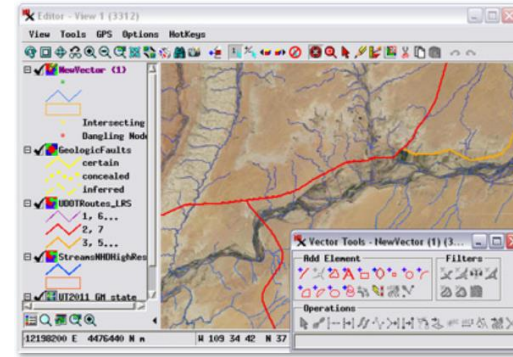




# GIS as a software

A real GIS software allows you to perform:

- Geospatial data management: All the disciplines related to managing geospatial data as a valuable resource (creating, editing,...)
- Thematic mapping: the process of creating thematic maps to convey information about a single topic or theme, such as population density or health.
- Spatial analysis: The process of examining the locations, attributes, patterns, and relationships of features in spatial data in order to address a question or gain useful knowledge
- Spatial modeling: A methodology or set of analytical procedures used to derive information about spatial relationships between geographic phenomena



➡ Software and applications not performing the above should not be considered a GIS software

# Not everything is a GIS software!



Database management systems with a thematic mapping interface

➡ «Bridges» with GIS software that are existing or under development



Online mapping applications



GIS Based application

➡ « Real » GIS software



- ArcMap, ArcGIS, ArcGIS Pro [www.esri.com](http://www.esri.com)
  - The most complete and versatile
  - Complete GIS ecosystem
  - Technical support
  - Proprietary (free/reduced cost licenses for the health sector)
- QGIS ([www.qgis.org](http://www.qgis.org))
  - Very good for thematic mapping, sometimes limited for other functionalities but constantly improved
  - Open Source, limited technical support
  - Free

# GIS – Open Source vs. Proprietary

The choice between the two must be based on the context, needs, and resources available.

Some examples:

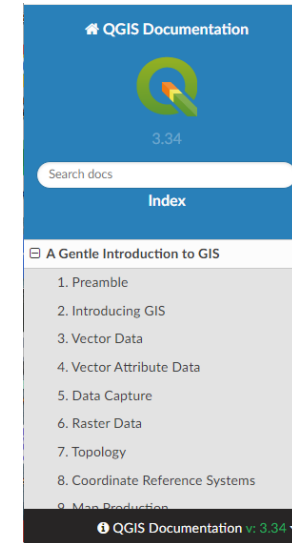
| Use   | Open source | Proprietary |
|---|-------------|-------------|
| Creation of thematic maps occasionally  | X           |             |
| Creation and management of quality geospatial data  | X           | X           |
| Mapping support in an emergency operations center   |             | X           |
| Need to be able to move directly from field data collection to an online and desktop solution |             | X           |

- ➡ Very often the solution is a combination of the two options
- ➡ The most important thing is to have access to quality data and qualified personnel and to ensure that the work carried out is based on solid and documented processes.

# GIS Resources - QGIS

The QGIS website provides resources for their users:

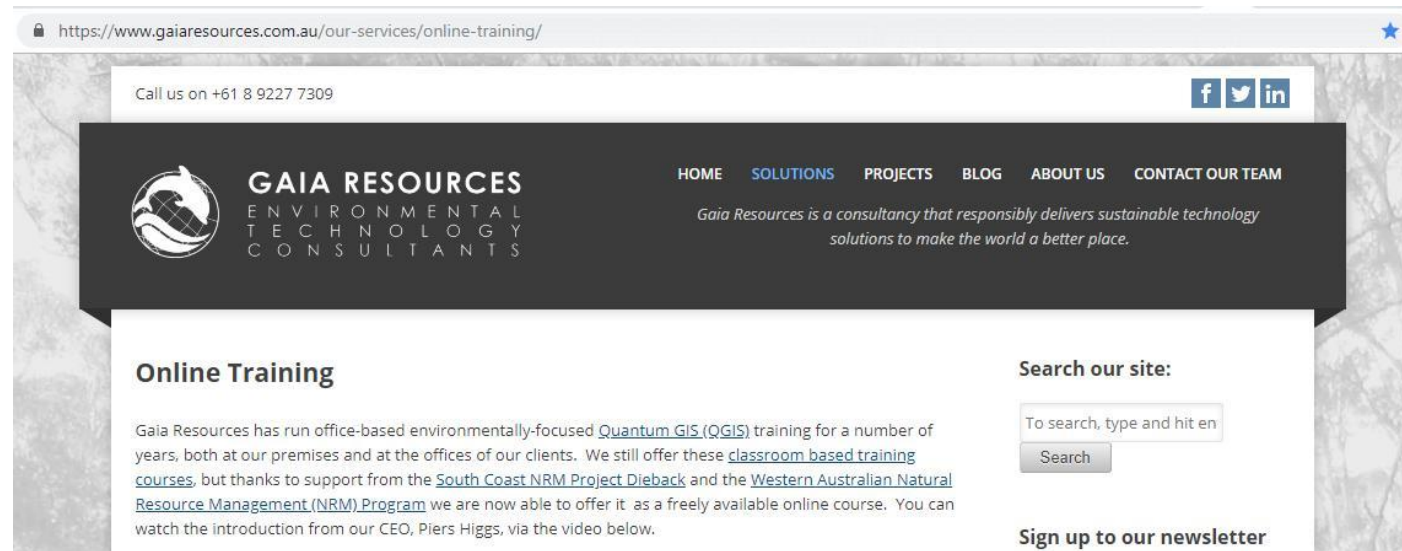
- A Gentle Introduction to GIS  
[https://docs.qgis.org/3.34/en/docs/gentle\\_gis\\_introduction/index.html](https://docs.qgis.org/3.34/en/docs/gentle_gis_introduction/index.html)
- QGIS User Manual
  - Online: [https://docs.qgis.org/3.34/en/docs/user\\_manual/](https://docs.qgis.org/3.34/en/docs/user_manual/)
  - PDF: <https://docs.qgis.org/3.34/pdf/en/QGIS-3.34-DesktopUserGuide-en.pdf>
- QGIS Training Manual
  - Online: [https://docs.qgis.org/3.34/en/docs/training\\_manual/](https://docs.qgis.org/3.34/en/docs/training_manual/)
  - PDF: <https://docs.qgis.org/3.34/pdf/en/QGIS-3.34-TrainingManual-en.pdf>



# GIS Resources - QGIS

There are different QGIS courses you can find online such as:

- YouTube offers many video tutorials on different QGIS topics: [www.youtube.com](http://www.youtube.com)
- Environmental QGIS Training from Gaia Resources:  
<https://www.gaiaresources.com.au/our-services/online-training/>



It is a self-paced course you can follow on YouTube:

[https://www.youtube.com/playlist?list=PLfInsSYJw1lQ\\_vii1wxPr7aKqBOziKVQ](https://www.youtube.com/playlist?list=PLfInsSYJw1lQ_vii1wxPr7aKqBOziKVQ)



# GIS Resources - Esri

Esri Global Public Health Grant Program: <https://bit.ly/2PjysU1>

Global Public Health Grant Program

Overview Eligibility Apply Now

## Global Public Health Grant Program

Esri grants provide GIS tools and training for ministries of health and government health agencies in countries with low- and middle-income economies.

Free for 2 years, very reduced cost after that

### What's included

The Global Public Health Grant Program for ministries of health and government health agencies provides access to the GIS tools needed for success. Recipients will receive the following:

#### Online

- ✓ 2 GIS Professional User Type licenses
- ✓ 3 Creator User Type licenses
- ✓ 5 ArcGIS Insights licenses

#### Extensions

- ✓ ArcGIS Spatial Analyst license
- ✓ ArcGIS Network Analyst license
- ✓ ArcGIS Geostatistical Analyst license

#### Desktop

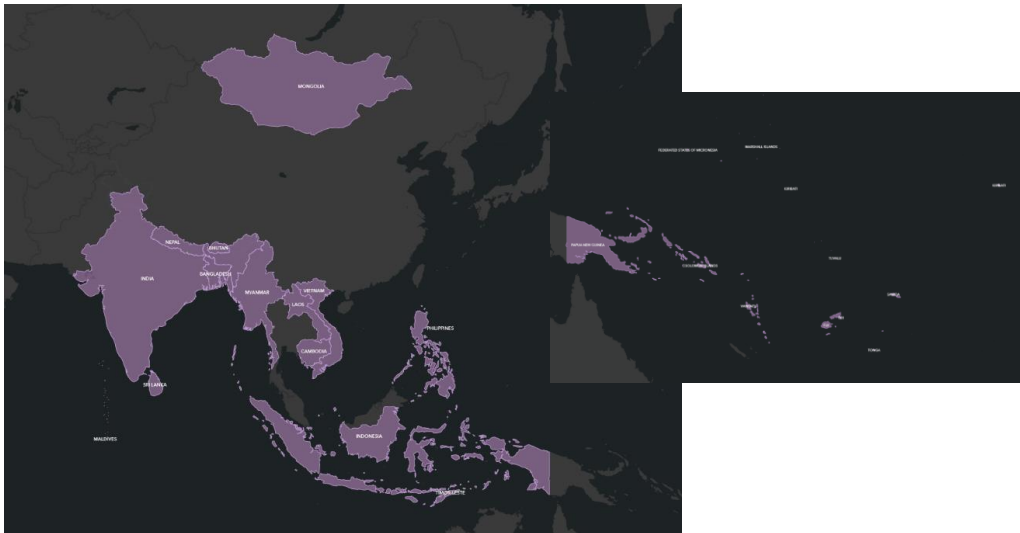
- ✓ 2 ArcGIS Pro Licenses (one for each GIS Professional License)

### After the grant period

After the two-year grant period, participants have the option to purchase a special low-cost software deal, ensuring that their software use is not interrupted. This access features the same software as the grant but can be purchased by multiple departments within a ministry or agency, allowing them to expand their use of geospatial tools. More information about this option will be shared with grant recipients towards the end of their two-year grant period.



Visit the website to see if your country is eligible for the grant (111 countries)



# GIS Resources - Esri

Geospatial Enablement Program for Global Public Health: <https://bit.ly/3AAVWBe>



## Geospatial Enablement Program for Global Public Health

A program that offers discounted software, training, and content for ministries of health and governmental health agencies in countries with low- and middle-income economies.



Offers more robust discounted software packages that include training and services

### What's included

With the program, ministries of health get access to tools, apps, and services that enable location-based strategies.



#### Core software

Esri software supports data visualization, advanced analysis, data maintenance, and sharing capabilities.



#### Access to content and data

Esri provides authoritative and ready-to-use content, including datasets, basemaps, and apps that supplement existing geospatial data.



#### ArcGIS Solutions

ArcGIS Solutions is a collection of industry-specific ArcGIS configurations to help you leverage authoritative data and improve operations.



#### Training and expert help

Esri offers many online training and in-person resources, such as passes to the Esri User Conference, discounted training courses, and seminars.

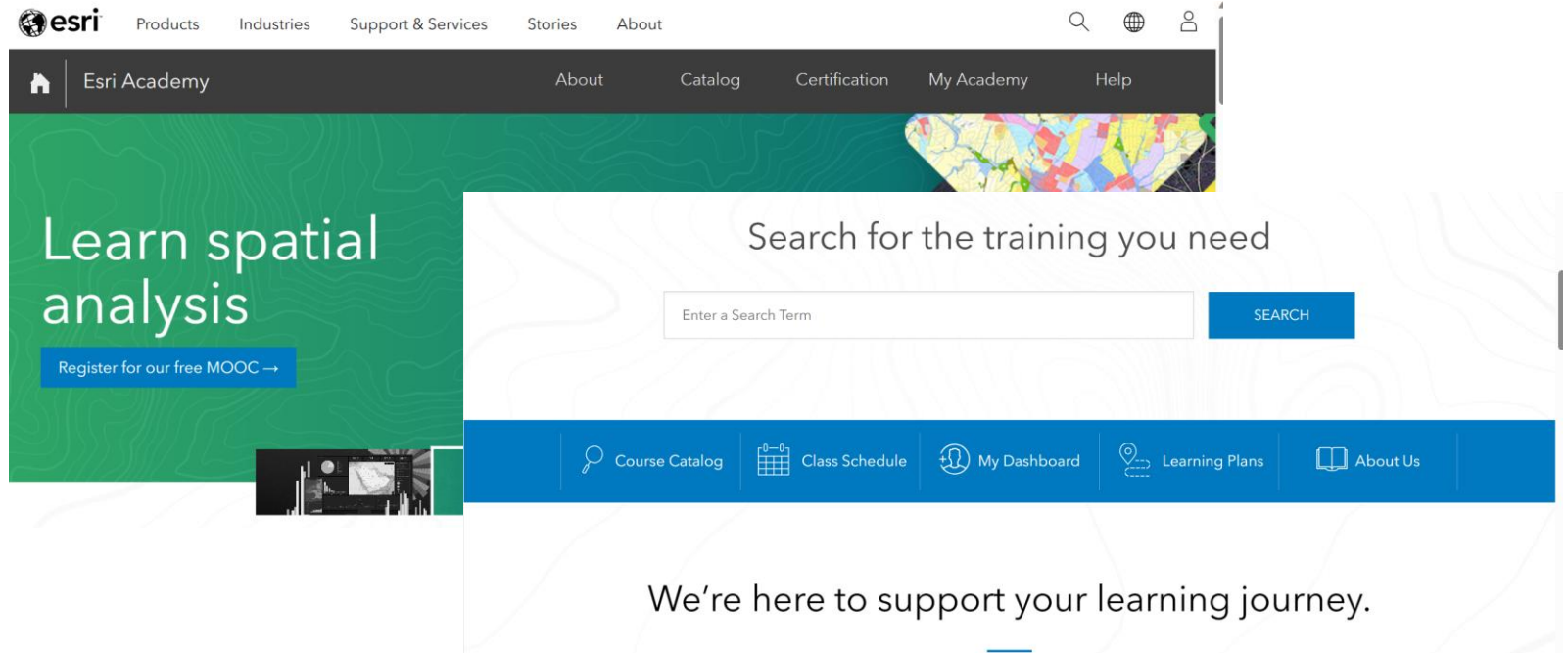
[globalhealth@esri.com](mailto:globalhealth@esri.com).



Visit the website to see if your country is eligible for the program

# GIS Resources - Esri

<https://www.esri.com/training/>



<https://healthgeolab.net/resources/reference-materials/>

## Starter kits

The following starter kits have then been developed to help new users to get started with Esri technology:

- [ArcMap 10.5 with authorization code starter kit](#)
- [ArcGIS Online](#)
- [Survey123 for ArcGIS](#)
- [Story Maps](#)
- [Unlimited access to Esri's e-Learning](#)
- [Migration to ArcGIS Pro](#)
- [ArcGIS Pro Map Series](#)
- [ArcGIS Solution Coronavirus Case Dashboard](#)

# GIS as an information system

“Information system set up by an organization to describe the spatial objects, phenomena and processes that are necessary for its action”

➔ Combines and articulates data, **equipment, software, organizational structures** (including personnel), and **methods** to represent and analyze geographic objects necessary for project implementation

➔ GIS is not just about software!

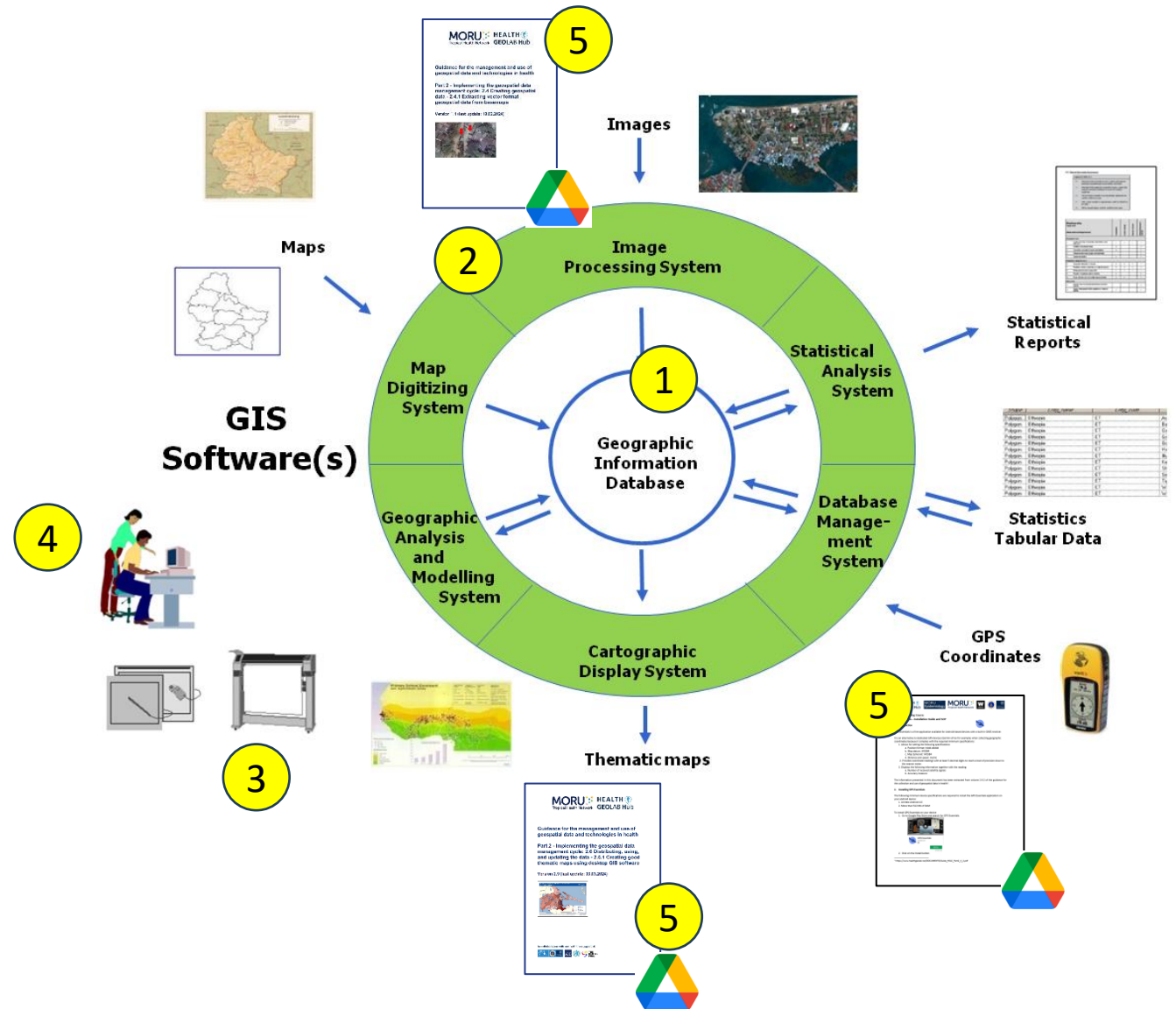


# Essential elements of a GIS as an information system

1. Data
2. Software
3. Equipment
4. People
5. Methods

➡ Data at the center of the system

➡ Part of a geo-enabled information system



# Geo-enabling the Health Information System, programs or interventions training workshop for Asia Pacific

*...and beyond*

Session 19: Introduction to the concepts of registry and Common Geo-Registry (CGR)

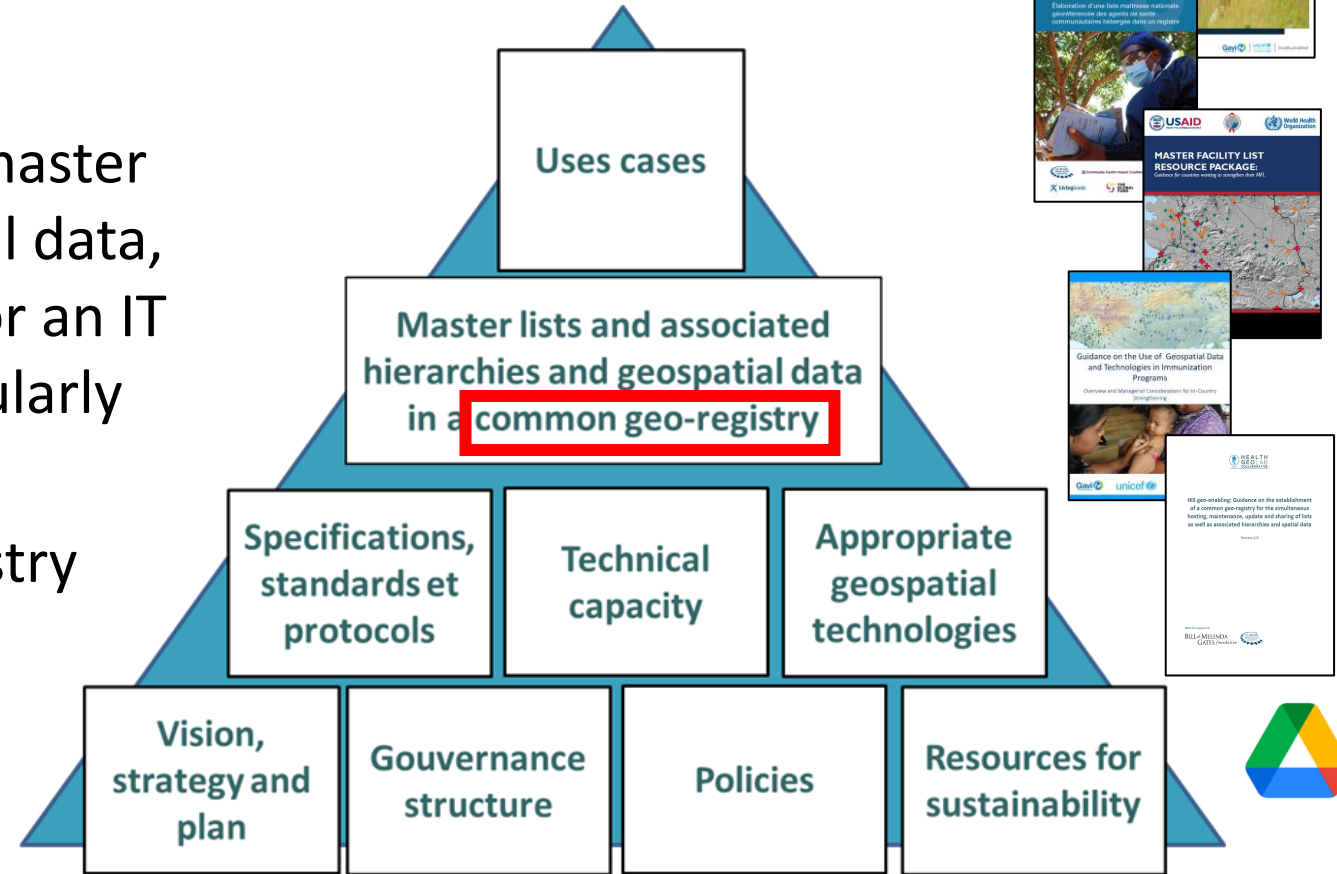
# The importance of the registry concept in the HIS geo-enabling framework

Master lists are pivotal to the framework and the operationalization of strong use cases supporting planning and decision making

As the information contained in these master lists, as well as the associated geospatial data, evolves through time, there is a need for an IT solution that would store, manage, regularly update and share them

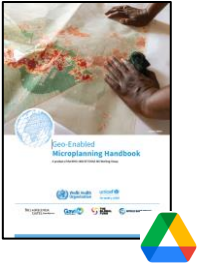
➡ Registry or common geo-registry

➡ Ideally deployed/developed and maintained as part of the geo-enablement of the HIS



# The concept of registry

An IT solution that allows storing, managing, validating, updating and sharing the master list for a specific geographic object. It is the “container” for the master list.



➡ Example of the Health Facility Registry Service (HFRS) from the Department of Health of the Philippines: <https://nhfr.doh.gov.ph/Home>



➡ Container that manages a single master list...

...but Public Health requires considering several types of geographic features/objects at the same time (health facilities, administrative units, villages, etc.) and these features/objects are connected to each other through different types of relationships (geographic, administrative, referral,...) and their proper geography. In addition, all this changes through time....

# ➔ The concept of Common Geo-Registry (CGR)

IT solution that allows the simultaneous hosting, management, regular update and sharing of all the master lists as well as associated hierarchies and geospatial data for the geographic objects core to development in general and public health in particular.

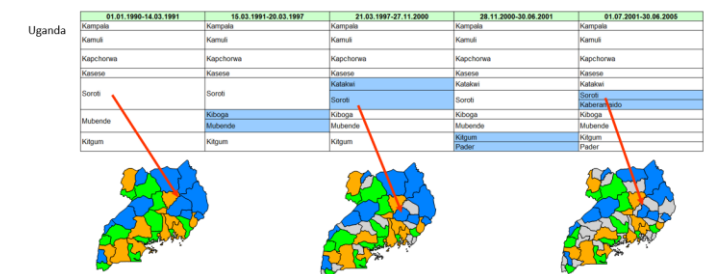
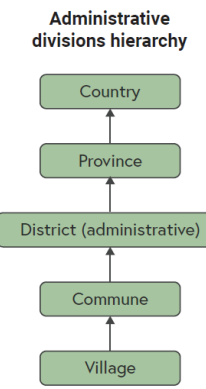
1



➔ Container that simultaneously manages, regularly update and multiple master lists and their associated hierarchies and geospatial data:

- Unlimited number of geographic features (facilities, administrative divisions, reporting divisions, villages,...) geographies and hierarchies
- Multiple organizations and different types of users
- Handles changes over time down to the data element level
- Accessible by any information system part of, or outside, the HIS
- Supports the National Spatial Data Infrastructure (NSDI)

|                                    | Fixed features                               |  | Mobile features   | Continuous features                          |
|------------------------------------|--|--|---|--|
|                                    | Point  | Polygon, line  |   |  |
| Examples                           |  |  |   |  |
| Way to capture the object in a GIS | Geographic coordinates (Latitude, Longitude) | Topology (location, size, shape) captured in a GIS vector format layer | Attached to a fixed feature (point or polygon) or geographic coordinate taken at a given time | Values captured in a GIS raster format layer |



1. [https://healthgeolab.net/DOCUMENTS/Guidance\\_Common\\_Geo-registry\\_Ve2.pdf](https://healthgeolab.net/DOCUMENTS/Guidance_Common_Geo-registry_Ve2.pdf)



# Common Geo-Registry (CGR) guidance

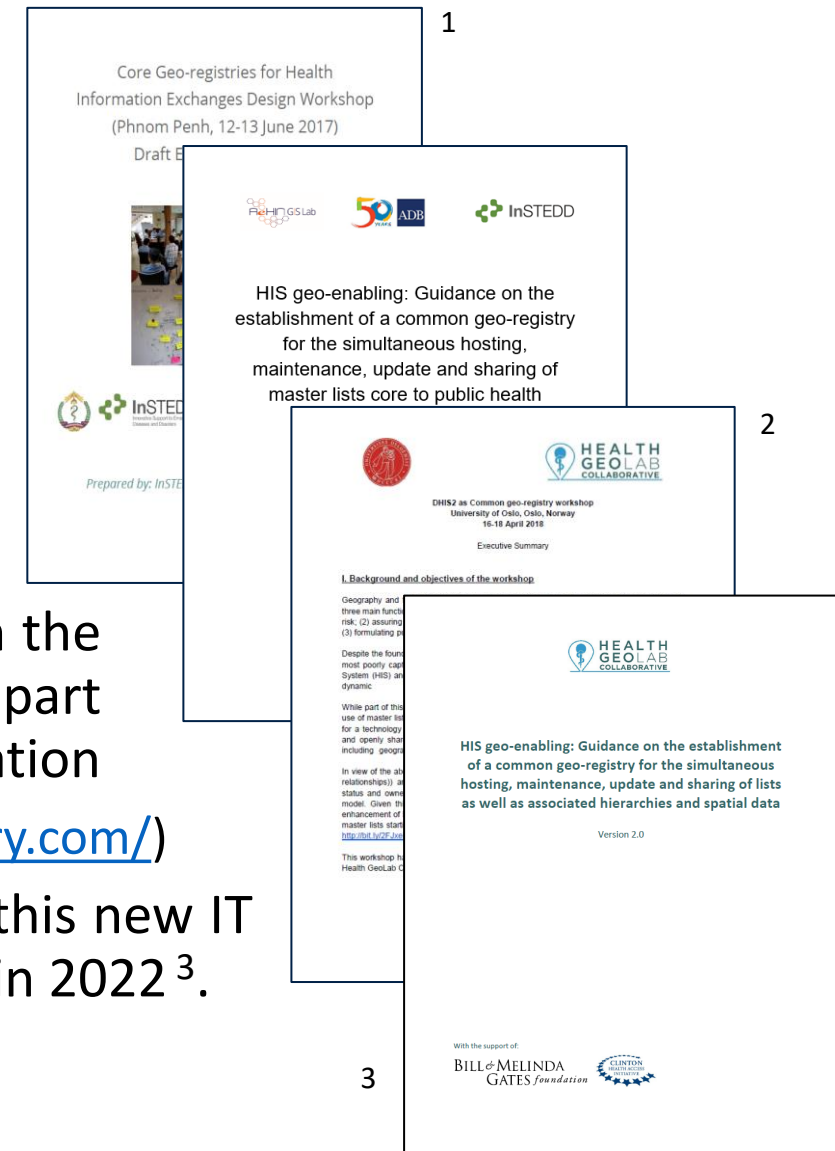
The concept of Common Geo-Registry is born during a workshop which took place in Phnom Penh in June 2017<sup>1</sup>.

The structure of the first version of the CGR guidance document was defined during this workshop

The first version of the CGR guidance was released in August 2017 and discussed during a workshop with the University of Oslo in April 2018 to identify if DHIS2 could serve as a CGR<sup>2</sup>.

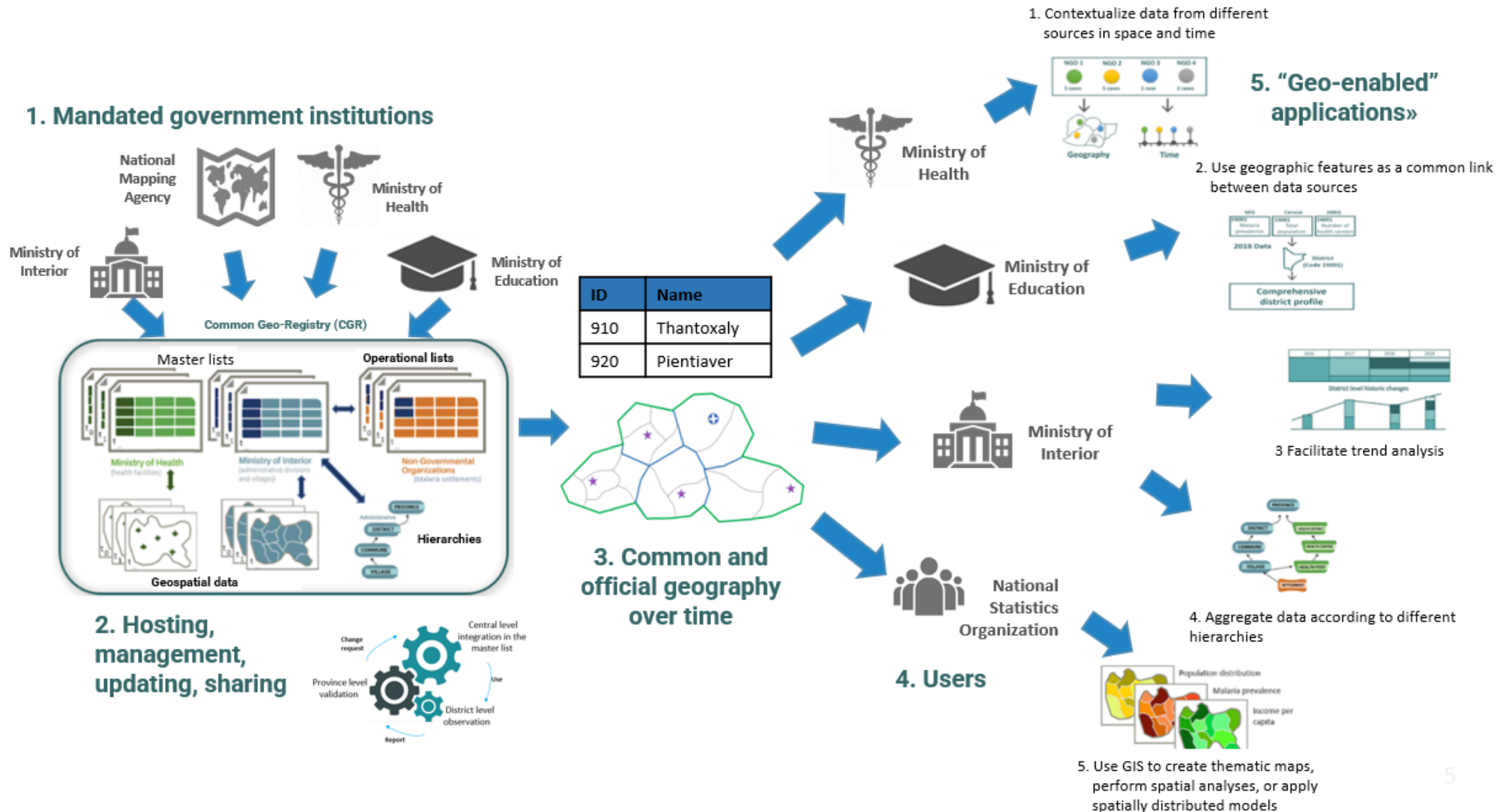
As neither DHIS2 nor other existing solution were complying with the requirements of a CGR, a new IT solution has been developed as part of the implementation of the Digital Solution for Malaria Elimination initiative (DSME) ➡ GeoPrism Registry (<https://geoprismregistry.com/>)

The lessons learned during the development and deployment of this new IT solution led to the release of the 2<sup>nd</sup> version of the CGR guidance in 2022<sup>3</sup>.



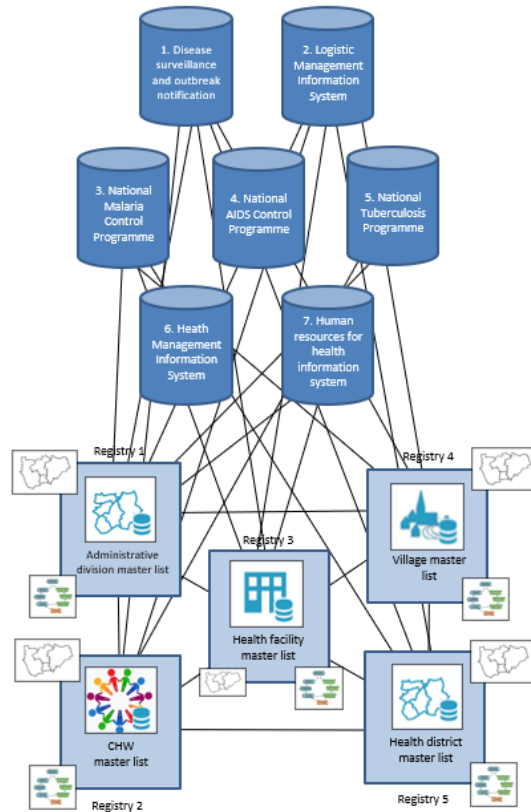
1. [https://www.healthgeolab.net/MEETINGS/CGR\\_2017/Geo-Registry Workshop\\_Final\\_Exec\\_Sum\\_010717.pdf](https://www.healthgeolab.net/MEETINGS/CGR_2017/Geo-Registry Workshop_Final_Exec_Sum_010717.pdf)
2. [https://www.healthgeolab.net/MEETINGS/CGR\\_OSLO\\_2018/DHIS2\\_CGR-Exec\\_Sum\\_April18.pdf](https://www.healthgeolab.net/MEETINGS/CGR_OSLO_2018/DHIS2_CGR-Exec_Sum_April18.pdf)
3. [https://healthgeolab.net/DOCUMENTS/Guidance\\_Common\\_Geo-registry\\_Ve2.pdf](https://healthgeolab.net/DOCUMENTS/Guidance_Common_Geo-registry_Ve2.pdf)

# The Concept of Common Geo-Registry (CGR)



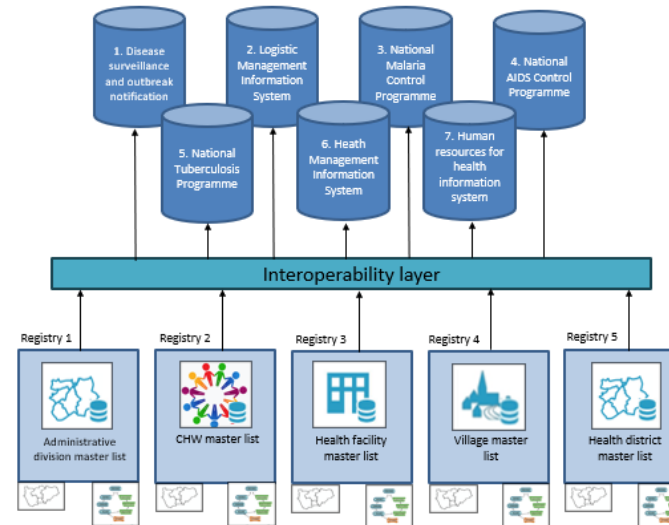
# From separated registries to a Common Geo-Registry (CGR)

## 1. One registry per geographic features, no interoperability layer



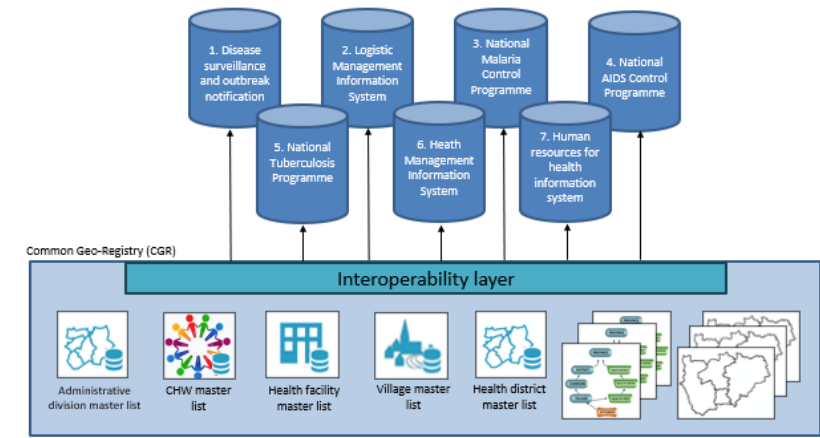
- Large number of registries to maintain
- Important volume of exchange to ensure data quality between registries and information systems
- Very difficult to scale up

## 2. One registry per geographic features with a separated interoperability layer



- Large number of registries to maintain
- Still a significant volume of exchange between registries to ensure data quality, including consistency between them
- Difficult to scale up

## 3. One common geo-registry with an integrated interoperability layer



- Only one registry to maintain
- Exchange only needed between the common geo-registry and each information system
- Facilitates data quality including consistency
- Easier to scale up



Model promoted by the HIS geo-enabling framework

# CGR or HFRS - Strategic outcomes

Strategic outcomes can be expressed in terms of the benefits that would be provided to the health sector once a HFRS or a CGR has been deployed and operationalized:

- Data standardization and quality: A CGR or HFRS enforces data standardization and, as such, the quality of the information collected and stored in the master list
- Interoperability: A CGR or HFRS enables data interoperability and sharing between information systems collecting, managing and or analyzing facility level data and information.
- Online access: A standardized CGR or HFRS facilitates online use of information contained in the master list including, when appropriate, the creation of a public-facing portal for users to access basic information about nearby health facilities
- Data-driven decision making: Well-maintained master list(s) accessible through a CGR or HFRS empowers policymakers, healthcare administrators, and stakeholders with accurate, ideally real-time data and reports. This facilitates evidence-based decision-making, allowing for informed policy formulation, strategic planning, and resource allocation
- Efficient resource management: By centralizing information about geographic features core to public health, a CGR or HFRS first reduces duplication of efforts through the centralized management and regular update of the master list(s). It then enables efficient resource allocation for better health care access and delivery. It aids in identifying gaps in services, redistributing resources, and strategically planning infrastructure development

# CGR or HFRS - Strategic outcomes

- Optimized public health interventions: Timely access to master lists of quality through a registry enables authorities to design and implement targeted public health interventions efficiently
- Enhanced coordination and collaboration: The sharing and accessibility of up-to-date information across various stakeholders within the healthcare system foster collaboration and coordination not only at the national but also regional and global level. This proves invaluable during emergencies, public health crises, and routine healthcare delivery
- Transparency and accountability: The transparency offered by comprehensive master list(s) hosted in a registry fosters accountability among healthcare providers and institutions. It allows for monitoring quality standards, compliance with regulations, and assessing the performance of facilities
- Innovation and research: Researchers and analysts benefit from the data contained in the registry to conduct studies, analyzing trends, and identifying areas for improvement. This aids in fostering innovation and driving advancements in healthcare practices

Programmatic benefits or use cases are not included here because a HFRS or a CGR are meant to support any program or intervention in view of the nature of their content



# CGR or HFRS - Technical outcomes

**HFRS:** A platform for storing, managing, and sharing the health facility master list and associated data and information

**CGR:** IT solution that allows the simultaneous hosting, management, regular update and sharing of all the master lists as well as associated hierarchies and geospatial data for the geographic objects core to development in general and public health in particular.

➔ The technical outcomes for both a CGR or HFRS are in their definition:

- Store: Provide the necessary functionalities to ensure the storage, security and scalability of the registry's content in a usable, reliable, cost-effective, and performing environment
- Manage: Provide the necessary functionalities for the authorized users to effectively manage the content of the registry and ensure its quality and integrity
- Share: Provide the necessary functionalities to ensure proper access to the registry's content as well as its exchange with other systems and applications as articulated by the national digital health enterprise architecture



➔ Business requirements

# CGR or HFRS – Strategic and technical outcomes

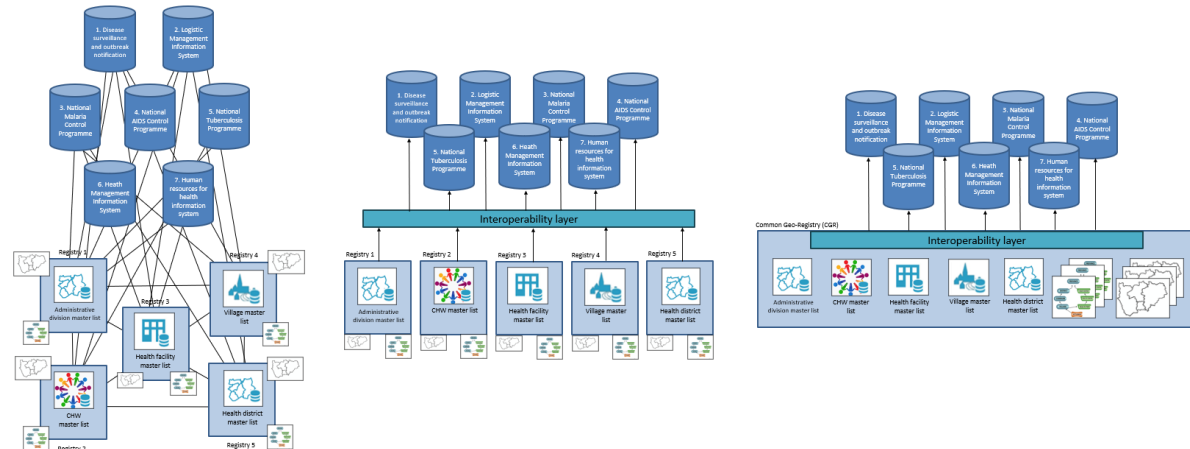
In conclusion the expected strategic and technical outcomes are the same for a HFRS or a CGR

➡ The difference between the two reside in the number of geographic features being managed

- Health Facility Registry Service (HFRS): once single geographic feature, health facilities in this case
- Common Geo-registry (CGR): an indefinite number of geographic features, including health facilities

➡ A CGR can be used as a HFRS but a HFRS can't be used as a CGR

➡ Strategic decision to be made considering the digital health infrastructure being implemented in the country

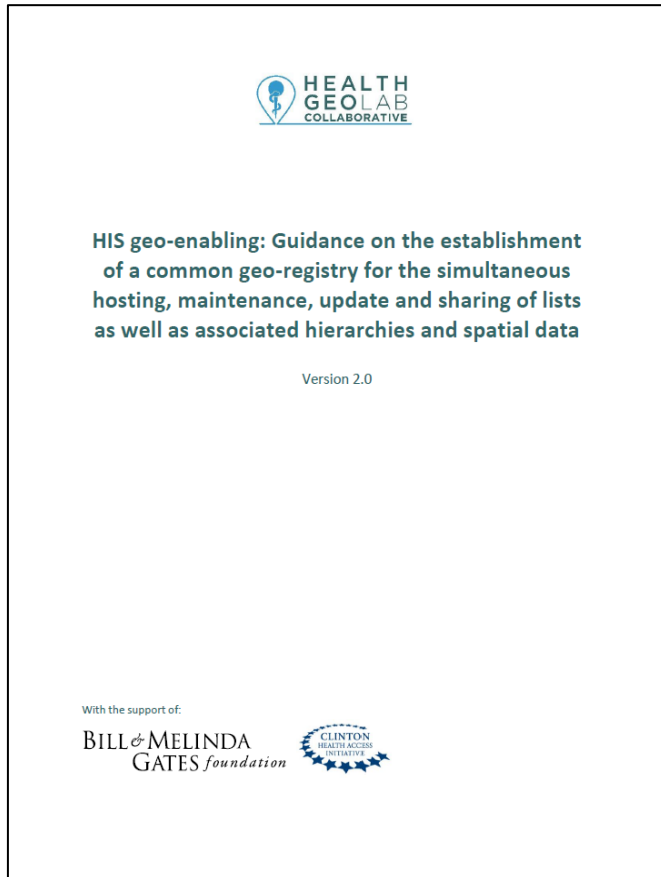


# Common Geo-Registry (CGR) guidance

## Table of content

1. Introduction (concept, use cases and benefits)
2. CGR content (geographic features and objects, data elements and classification tables, hierarchies and conceptual data model, lists, geospatial data, changes over time, content related considerations)
3. CGR functional requirements (data and information flow, organizations and users, required functionalities)
4. CGR supporting environment (HIS geo-enabling framework)
5. Conclusion

➔ Content to guide countries in the choice of the appropriate IT solution to serve as a CGR



# Functional requirements - CGR

## Annex 4 – CGR minimum required functionalities

### 1. CGR setup (11 required functionalities)

At the platform level:

1. Manage different organizations (create, edit, deactivate)
2. Support different data governance models (centralized, decentralized, federated)
3. Capture organization information
4. Provide organization information to users who need it
5. Manage localization for the user interface (select, import, edit, export)
6. Invite organizations to the CGR

At the organization level:

7. Define roles having specific rights down to the geographic object type level (e.g., administrator, maintainer, contributor)
8. Manage user accounts (create, edit, deactivate)
9. Assign a role to each user
10. Provide user information to users who need it
11. Invite users to the CGR

### 2. Define geographic object types, data elements, classification tables, and hierarchies (27 required functionalities)

Geographic object types:

1. Handle as many geographic object types as needed to cover the defined conceptual data model
2. Attach each geographic object type to a specific organization
3. Manage geographic object types (add, edit, delete)
4. Manage metadata for each geographic object type
5. Differentiate between master and non-master geographic object types
6. Specify access rights for each geographic object type (public, restricted, or private)
7. Define the geometry for each geographic object type (point, line, polygon)
8. Handle changes over time for each geographic object type down to a specific date (temporal validity of a given geographic object type)
9. Group geographic object types for the purpose of generating lists at the group level
10. Manage (add, edit, delete) core CGR data elements (uniquely identify, classify, locate, and contact) and store them in a data dictionary
11. Handle the format necessary to manage the core CGR data elements (text, date, Boolean, enumerated) as well as multiple languages
12. Manage metadata for each data element
13. Specify if the values for a particular data element are meant to be unique
14. Specify access rights for each data element (public, restricted, or private)
15. Specify if a particular data element is mandatory when adding new geographic objects
16. Create, edit, delete, and export the classification table associated with the enumerated data elements

53

Hierarchies:

17. Handle as many hierarchies as needed to cover the defined conceptual data model
18. Attach a hierarchy to a specific organization
19. Differentiate between master and non-master hierarchies
20. Specify access rights for each hierarchy (public, restricted, or private)
21. Manage hierarchies (add, edit, delete)
22. Graphically visualize the structure and content of a hierarchy
23. Handle changes over time down to a specific date (temporal validity of a hierarchy)
24. Manage metadata for each hierarchy
25. Use the same geographic object type in several hierarchies (no duplication of information)
26. Combine geographic object types from different organizations in a given hierarchy
27. Inherit the structure of other hierarchies having a geographic object type in common
28. Export a hierarchy in the form of a report

### 3. Import lists and geospatial data (6 required functionalities)

1. Import lists separately from geospatial data
2. Import the data either from the user's computer or from an external system
3. Specify the period over which the data being imported is valid (start/end date)
4. Specify the type of import (information for new records, update of existing information (overwrite), filling of value gaps)
5. Specify for which data elements the data is being imported, including the parents of the geographic object across the hierarchies in which it is included for the concerned organization
6. Match the data elements in the file being imported with those defined at the geographic object type level

### 4. Curate lists and geospatial data (9 required functionalities)

1. Identify and correct data element format validity issue (e.g., text imported against a date format data element)
2. Identify and correct hierarchy inconsistencies (correct parent attribution across the concerned hierarchies)
3. Identify and correct duplicates across geographic objects of the same type
4. Identify and correct temporal gaps for a given data element (missing values over a given period)
5. Identify and correct gaps for a given data element across all geographic objects of a same type (e.g., health facilities for which the type is missing)
6. Inform users about changes in the upper part of a hierarchy (e.g., creation of a new administrative unit requires the health facilities to be re-attributed according to the new structure)
7. Identify and correct orphans in a given hierarchy (e.g., new village not yet attached to a health facility as part of a catchment area)
8. Identify when the information for a given data element has been updated for the last time across all the geographic objects
9. Prevent from sharing the content from the working environment until it has been completely curated

54

### 5-7. Manage and share CGR content (29 required functionalities)

Lists:

1. Manage (create, edit, delete) as many lists as needed
2. Attach each list to a specific organization
3. Differentiate between master and non-master lists
4. Specify access rights (public, restricted, or private)
5. Make the distinction between the lists in the working environment and those that are being shared with users outside the organization
6. Use a unique set of geographic objects to generate any list (no duplication of geographic objects across the CGR)
7. Integrate multiple hierarchies in the same list or a different hierarchy in separate lists
8. Manage the metadata of each list
9. Access the data dictionary for the data elements included in the list
10. Manage lists at the geographic object level (add, edit, deactivate)
11. Handle data element changes over time down to a specific date
12. Create, visualize, and edit lists for any given temporal validity (date, period) without losing other data
13. Persist different versions of lists for each temporal validity to preserve what was referenced in the past (e.g. 01.01.2020-v1, 01.01.2020-v2, 01.01.2020-v3)
14. Explore the content of a list for a given temporal validity (date), including search and filter
15. Export lists for a given temporal validity (date, period) in a format readable by users together with metadata and data dictionary
16. Access the list and associated information, including metadata through a REST or streaming API

Geospatial data:

17. Manage (create, edit, delete) geospatial data associated with any list
18. Attach each geospatial data to a specific organization
19. Enable/disable geometry editing by geographic object type
20. Differentiate between master and non-master geospatial data
21. Specify access rights (public, restricted, or private)
22. Make the distinction between the geospatial data in the working environment and those that are being shared with users outside the organization
23. Manage the metadata of each geospatial data
24. Access the data dictionary for the data elements included in the attribute table of the geospatial data
25. Manage geospatial data at the geographic object level (add, edit, delete geometry)
26. Handle changes in geometry over time down to a specific date
27. Create, visualize, and edit geospatial data for any given temporal validity (date, period) without losing other data
28. Persist different versions of geospatial data for each temporal validity to preserve what was referenced in the past (e.g. 01.01.2020-v1, 01.01.2020-v2, 01.01.2020-v3)
29. Explore geospatial data on a map for a given temporal validity (date) including search and filter
30. Export geospatial data in a usable format for a given temporal validity (date or period) with metadata and data dictionary
31. Access the geospatial data with metadata through a REST or streaming API

55

Historical changes:

1. Capture and export changes over time for given geographic objects in the form of a report
2. Provide a REST API that supports queries on historical changes

### 8. Submit and treat change requests (6 required functionalities)

1. Submit change requests for any of the data elements associated with a given geographic object type (add, edit, deactivate) and a given temporal validity (date, period)
2. Review, accept, or reject the change requests that have been submitted down to the data element level
3. Provide the necessary information for the request to be reviewed (information before and after the change, temporal validity of the new information, reason for the request, etc.)
4. Provide the necessary information to follow up with the user who submitted the request if needed
5. Consult and monitor the change requests that have been submitted (including filtering and search)
6. Modify the change requests that have been submitted as long as they have not been reviewed

56

➔ 93 functional requirements without criticality level



# Health Facility Registry Service (HFRS) toolkit

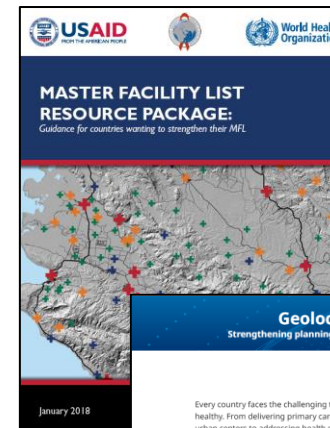
The Master Facility List Resource package released by WHO in January 2017 launched the concept of a Facility Registry Service as a software solution that stores and shares the Master Facility List (MFL)

As part of its activities, the WHO Geolocated Health Facilities Data (GHFD) initiative established a Sub Working Group on Health Facility Registry Minimum Requirements (subWVG RMR)

The toolkit to support the identification and deployment of a Health Facility registry Service (HFRS) in countries is born from the activities of this Sub Working Group

➔ Still to be published but we have started testing it in countries (e.g. Cambodia)

1



2



**Toolkit to support the identification and deployment of a health facility registry service in countries**



1. <https://www.who.int/publications/i/item/-9789241513302>

2. <https://www.who.int/data/GIS/GHFD>

# Health Facility Registry Service (HFRS) toolkit

## Table of content

1. Introduction (concept, use cases and benefits)
2. Step 1 – Establish a technical working group
3. Step 2 – Define the expected outcomes (strategic and technical)
4. Step 3 – Assess the current enabling environment (HIS geo-enabling framework)
5. Step 4 – Define what the HFRS needs to do (Data ecosystem, task flows, user roles, functional and non-functional requirements)
6. Step 5 – Find the appropriate IT solution
7. Step 6 – Develop the implementation, monitoring and evaluation and communication plans
8. Step 7 – Understand and manage risks

**Toolkit to support the  
identification and  
deployment of a health  
facility registry service in  
countries**



➡ Organized as a process to guide countries to choose the appropriate IT solution to serve as a HFRS

# Functional and non-functional requirements - HFRS

Functional requirements: Product features or functions that developers must implement to enable users to accomplish their tasks

Non-functional requirements: Requirements describing how a system should perform

| Requirement code | Requirement wording     |  | Requirement type                                   | Criticality level        |
|------------------|-------------------------|--|--|--------------------------|
| RMR F1           | <b>Requirement code</b> | <b>Requirement wording</b>   | <b>Requirement type</b>                            | <b>Criticality level</b> |
| RMR F2           | RMR F8                  | Data Import: Support data import to enable the bulk addition of facility information   | Functional requirement (data import)               | Required                 |
| RMR F3           | RMR F9                  | Comprehensive time management and data preservation: Provide comprehensive time management and data preservation functionalities, including effective dating, historical data retention and time-based reporting   | Functional requirement (time dimension management) | Required                 |
| RMR F4           | RMR F10                 | Data validation and quality control: Implement data validation checks to ensure alignment with defined standards, prevent the entry of inaccurate or incomplete information as well as data quality control including but not limited to identifying missing and/or out-of-date information, cross-referencing, deduplicating, data cleansing and ensuring data consistency through time to maintain the high quality of the HFRS' content | Functional requirement (quality control)           | Required                 |
| RMR F5           | RMR F11                 | Basic reporting and analytics: Provide basic reporting and analytics that facilitate data curation and allow users to have a general overview of the master list's content for a given date (e.g. number of health facilities by type)   | Functional requirement (reporting & analytics)     | Recommended              |
| RMR F6           | RMR F12                 | Advanced reporting and analytics: Provide advanced reporting and   | Functional   |                          |
| RMR F7           | RMR F13                 | Updating mechanism: Operationalize the updating mechanism that has been defined to support the curation and regular update of the health facility master list content (closures, openings, data element changes)   | Functional requirement (updating mechanism)        | Required                 |
|                  | RMR F14                 | Versioning: Support version control system that allows users to view and compare different versions of the HFML for a given date, facilitating effective tracking of data changes.   | Functional requirement (versioning)                | Recommended              |
|                  |                         | Notification and alerts: Provide a notification system to alert users about updates and/or changes in the health facility master list based on their specific needs  | Functional requirement (notification)              | Optional                 |
|                  |                         | Data Export: Support data export to an Excel spreadsheet to enable the bulk extraction of facility information with the associated data dictionary and metadata in an Excel spreadsheet and other format as needed (e.g. .csv) as well as the associated geospatial data when applicable   | Functional requirement (Data export)               | Required                 |

| Requirement code | Requirement wording     |   | Requirement type                          | Criticality level        |
|------------------|-------------------------|---|---|--------------------------|
| RMR NF1          | <b>Requirement code</b> | <b>Requirement wording</b>  | <b>Requirement type</b>                   | <b>Criticality level</b> |
| RMR NF2          | RMR NF8                 | User-friendly interface: Provide an intuitive, user-friendly interface that allows authorized users to navigate the system and perform tasks efficiently.   | Non-functional requirement (usability)    | Recommended              |
| RMR NF3          | RMR NF9                 | User training resources: Provide user documentation, training materials, and support resources to help users learn to use the system effectively.   | Non-functional requirement (usability)    | Recommended              |
|                  | RMR NF10                | Public access: Allow public access to view data that is relevant and accessible to the public.  | Non-functional requirement (usability)    | Recommended              |
| RMR NF4          | RMR NF11                | Mobile access: Provide the capacity to access the HFRS for consultation and the submission of change requests while in the field  | Non-functional requirement (usability)    | Optional                 |
|                  | RMR NF12                | Language localization: Support full language localization of the platform (screens, prompts, tooltip help, pick lists, metadata field names, and messages (except unanticipated system-level error messages) should be available in the user's default language to the extent translations are available. | Non-functional requirement (localization) | Required                 |
| RMR NF5          | RMR NF13                | Governance model: Support the HFML's data governance models in place (centralized, decentralized, federated)  | Non-functional requirement (localization) | Recommended              |
| RMR NF6          | RMR NF14                | Hosting model: Support the preferred hosting model for the health facility master list (cloud or locally hosted)  | Non-functional requirement (localization) | Recommended              |
|                  | RMR NF15                | Accessibility: Support accessibility features available in the operating environment as described in level A of the W3C Web Content Accessibility Guidelines v. 2.0   | Non-functional requirement (localization) | Optional                 |
| RMR NF7          | RMR NF16                | Data exchange: Provide flexible standards-based APIs (e.g. RESTful API, HL7 FHIR) for data exchange and this in alignment with the in-country existing information system architecture  | Non-functional (interoperability)         | Recommended              |

➡ Also applicable to a CGR

➡ 24 functional and 16 non-functional requirements with recommended criticality level

# Module 6 – Schedule and Agenda

| Schedule Module 6<br>11 September 2024 (Bangkok 12pm / Geneva 6am / Fiji 6pm)  |
|--|
| 15 min - Recap of Module 5 and agenda of Module 6  |
| 15 min - <b>Session 20:</b> Define the strategy(ies) to be implemented to fill the gaps identified during the assessment |
| 30 min – <b>Session 21:</b> Develop the action plan aiming at filling the gaps in the HIS geo-enabling framework         |
| 30 min - <b>Session 22:</b> Implement the action plan  |
| 30 min – <b>Session 23:</b> Assess, document and sustain the result of the action plan implementation                    |
| 15 min - <b>Session 24:</b> HIS, program or intervention geo-enabling resources (recap and additional ones)              |
| 15 min - End of workshop   |

➔ Development and implementation of the action plan



**Thank you for your attention and  
see you all again soon!**