Geospatial Data for Advancing Health-related SDGs

Ramesh S. Krishnamurthy, PhD, MPH, PHIF
Senior Advisor, Health Systems and Innovations Cluster
World Health Organization
Key Messages

• Integration of geospatial data to health systems strengthening efforts shall be more widely practiced in the context One Health, SDG 2030 and UHC.

• At national-level, legal mandate is essential for closer collaboration between Ministry of Health and other relevant ministries and space agencies to leverage the benefits of geospatial data for health gains.
World Health Organization

United Nations specialized agency for building a better, healthier future for people all over the world
WHO at a glance

- 194 Member States
- Headquarters in Geneva
- 6 regional offices
- More than 150 country offices
- More than 7000 staff
- More than 700 institutions supporting WHO’s work
- Close partnerships with UN agencies, donors, foundations, academia, nongovernmental organizations and the private sector

Regions:
- Region of the Americas
- African Region
- European Region
- Eastern Mediterranean Region
- South-East Asia Region
- Western Pacific Region
World Health Assembly
the decision-making body of WHO
Human health in the context of One Health

the interconnectedness of human health, animal health and the ecosystem
One Health

Source: OIE, 2016; http://www.oie.int/for-the-media/onehealth/
One Health

60% of existing human infectious diseases are zoonotic

At least 75% of emerging infectious diseases of humans (including Ebola, HIV, and influenza) have an animal origin

5 new human diseases appear every year. Three are of animal origin

80% of agents with potential bioterrorist use are zoonotic pathogens

Source: OIE, 2016; http://www.oie.int/for-the-media/onehealth/
Relevance of Geospatial data to health-related SDGs

Leveraging benefits of space science, geospatial data for advancing health agenda
### HEALTH IN THE SDG ERA

#### TARGETS

| **3.1** | By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births. |
| **3.4** | By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote healthy lifestyles. |
| **3.8** | Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines. |
| **3.3** | ------------- |
| **3.2** | ------------- |
| **3.5** | ------------- |
| **3.6** | ------------- |
| **3.9** | ------------- |

#### INDICATORS

| **3.1.1** | Maternal mortality ratio |
| **3.4.1** | Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease. |
| **3.8.1** | Coverage of essential health services (defined as the percentage of the population with coverage of essential services based on tracer indicators) |
| **3.8.2** | Coverage of essential medicines and vaccines. |
| **3.8.3** | Proportion of the population with access to affordable essential medicines and vaccines on a sustainable basis. |

| **3.3.1** | Health worker density and distribution |

| **3.8.4** | International Health Regulations (IHR) capacity and emergency preparedness |

---

[World Health Organization](http://www.who.int/sdg)
## Matrix of Relevance

<table>
<thead>
<tr>
<th>SDG</th>
<th>Geospatial Data and Health Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1: No Poverty</strong></td>
<td>Prioritizing the health needs of the poor</td>
</tr>
<tr>
<td><strong>2: Zero Hunger</strong></td>
<td>Addressing the causes and consequences of all forms of malnutrition</td>
</tr>
<tr>
<td><strong>6: Clean water and sanitation</strong></td>
<td>Preventing diseases through safe water and sanitation for all</td>
</tr>
<tr>
<td><strong>10: Reduced inequalities</strong></td>
<td>Ensuring equitable access to health services through Universal Health Coverage Based on stronger primary care</td>
</tr>
<tr>
<td><strong>13 Climate Action</strong></td>
<td>Protecting health from climate risks, and promoting health through low-carbon development</td>
</tr>
<tr>
<td><strong>14: Life below water</strong></td>
<td>Supporting the restoration of fish stocks to improve safe and diversified healthy diets</td>
</tr>
<tr>
<td><strong>15: Life on land</strong></td>
<td>Promoting health and preventing diseases through healthy natural environments</td>
</tr>
</tbody>
</table>
Use of space science and technology in environmental health and health systems research
Mapping WASH and NTDs...hotspot analyses

Source: Rifat Hossain, WHO, 2015
Topographic map from ALOS is useful in developing countries. Road network is essential to deliver vaccines and to visit medical facilities.
Example of MODIS Satellite

JAXA’s GCOM-C will continue to observes surface temperature, which can be used for countermeasures of heat stroke.

Source: JAXA, 2014
Tracking of spread of animal born diseases:
Small Animal Tracking from ISS: DLR ICARUS Project
Polio eradication project: Locating sample sites on the satellite images and tracking over time using JAXA’s 5-m resolution DEM data.
A Remote-sensing tool applied to Rift Valley Fever (RVF) Monitoring

Identify environmental factors of A. vexans & C. poicilipes presence by remote sensing to obtain risk map

SPOT5 multispectral image high spatial resolution -10m (Program ISIS/CNES)

Zones Potentially Occupied by Mosquitoes (ZPOM)

1354 ponds

Mosquitoes flying range ~500m (Bâ et al., 2005)

Ponds detection NDPI

Characterization NDVI & NDTI

Ponds’ area

Ponds’ characterization

Turbidity

Vegetation activity gradient

Vegetation Cover

Turbidity gradient

26/08/2003

Ponds ~ 1%

ZPOM = 25%

26/08/2003

© CNES 2003, Distribution Spot Image SA

© CNES/OMP product, CNES 2003, Distribution Spot Image SA
This shows ALOS 3-D mapping capacity. It is the world’s most accurate vertical resolution, 5m, among satellites.
B-LiFE at Ebola treatment centre

Last Accessed: 13/09/2016 16:14

http://www.esa.int/spaceinimages/Images/2015/04/B-LiFE_at_Ebola_treatment_Centre

ESA: Telecommunications and Integrated Applications
Health Facilities Locator

Locating health facilities using space-based technologies: Mapping of health facilities
Metrics and Measurements

Data for evidence-informed decision-making

Integrating geospatial data as part of national health information architecture
Health Information System Landscape

A Set of Complex Sub Systems

HIS Sub Systems

Extract, transform and load data into warehouse

Census
Vital Event Registry
Surveys
Health Events & Risks
Health Service Records
Resource Tracking

Data Warehouse

Information Services

Policy
Resources
Processes

Data Collection
Forms & Methods

Statistical Systems

Financial Systems

Health system data generally found at Health Ministries

Health-relevant earth observation data generally found outside Health Ministries

Common health-relevant data sources

- Censuses
- Civil Registration
- Population Surveys
- Individual Records
- Resource Records
- Service Records
- Earth Observation Data
Examples of earth observation data

Near-real-time health-relevant earth observation data obtained from satellites

- 375 m Active Fire
- Aerosols
- Brightness Temperature
- Carbon Monoxide
- Cloud motion vectors (Winds)
- Cloud Top Pressure
- Clouds and Trace Gases
- Clouds/Aerosols
- Columnar Cloud Liquid Water over ocean
- Columnar Water Vapor over ocean
- Corrected Reflectance Imagery
- Dust
- Fire
- Global Rainfall
- Global Total Precipitation
- Land Surface Reflectance
- Land Surface Temperature
- Moisture Profiles
- Nitric Acid
- Nitrous Oxide
- Ocean Wind Speed
- Ozone Profile
- Ozone
- Precipitation
- Radiances
- Retrieved Carbon Monoxide
  \(\text{(Thermal Infrared Radiances)}\)
- Sea Ice Concentration
- Sea Ice
- Snow Cover
- Snow Water Equivalent
- Soil Moisture
- Sulfur Dioxide
- Temperature
- Total Column Ozone and Aerosol Index
- Total Precipitable Water
- Water Vapor

**Example of dataset required for national unified health information system**

<table>
<thead>
<tr>
<th>Data set required for</th>
<th>Prevention</th>
<th>Preparedness</th>
<th>Response</th>
<th>Recovery</th>
</tr>
</thead>
</table>

### Data from Routine Health Information Systems

(Health Management Information Systems, Routine disease-specific information systems; other health information sub-systems; national emergency operations systems situation reports; NCD and environmental health data)

- Complete list of diseases, health conditions
- Health facilities list (all types and levels)
- Essential medicines list
- Satellite Imagery (various types and resolutions)
- GIS with shape files, base maps and commonly used layers

#### Subject-specific financial Data

- List of donor and partner agencies
- Health workforce data (all cadre)
- Supply-chain information
- Other context-specific data

#### Other context-specific data

- National public assets data (Airport locations, transportation hubs, Road network maps)
- Country-specific population data (national/sub-national level; projections, census, actual)

#### Outbreak-related health data

- Essential medical devices list
- Other remotely sensed data (temperature, precipitation, terrain and topology)
Cross sectional View of Relevance of Space Science to Public Health

Source: Krishnamurthy, R. 2017
Future Health Information Platforms

Health information platform for monitoring public health combined with context specific geospatial data.
Earth Observation and Geospatial Data

Digital Elevation Model (DEM): Worldwide coverage from NASA’s ASTER mission with 30-meter resolution.


Improved water source location: Location of wells continually updated with new water projects via interactive Web 2.0 application.


Water accessibility: (combination of layers) Access measured in amount of energy per capita (calories) needed to collect water, highlighting access limitations due to terrain. Also shows populations living on marginal land without water access.

Water resources per person: Determines whether underlying water resources (aquifer yield) can meet demand of overlying population based on 50 liters per person per day.

Areas with improved water access: (combination of layers) Displays 1-km LandScan areas that have achieved water access per guidelines, i.e. at least one access point per 1-sq.km.

Source: Rifat Hossain, WHO, 2015
Strengthening national capacities for utilizing earth observation data to advance national health-related SDG 3 targets

Need for a Conceptual Framework
Components of the Framework

1. **National readiness** for using earth observation data in conjunction with routine health systems data

2. **Multi-sectoral engagement** for establishing earth observation data utilization environment in the national context

3. **Alignment** of stakeholders, strategies, and efforts
Conceptual Framework for Country Capacity Development
For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Established EO/RS data utilization environment

Emerging legal/policy environment for geospatial data analytics

Level 3
Developing and building up capacity

Level 2
Strengthening infrastructure, make the case for digital health environment

Level 1
Early adoption

Emerging EO/RS data utilization environment

Mainstreaming

Scaling-up and integration, cost-effectiveness, policies for privacy, security and innovation

Established digital health infrastructure, governance, policy, standards, resources

Beginning of penetration of digital health infrastructure and computing environment

Level 1
National readiness
Level 2
Level 3
Level 4

Level = National Readiness for utilizing Earth Observation Data in combination with routine health systems data
Conceptual Framework for Country Capacity Development
For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Multi-sectoral engagement
Examples of Partners within Health Information Landscape

- Ministry of Health
- Ministry of Finance
- Ministry of Education
- Ministry of Labour
- Ministry of Telecommunications
- Ministry of Infrastructure
- Ministry of Science and Technology
- Academia and Private Health Sector
- Donors and Implementing Partners

Coordination is essential to owning and sustaining data analytics capacities at National and Sub-national Levels
Conceptual Framework for Country Capacity Development
For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Align Stakeholders

Activities related to SDG 3 targets
(stakeholder’s positions vary depending on the model)

Value Chain of Solutions
driven by Public Private Partnerships

Better Health Outcomes
Conceptual Framework for Country Capacity Development
For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Align Strategies

Health Information Activities
(stakeholder’s positions vary depending on the model)

Value Chain of Solutions
driven by Public Private Partnerships
Conceptual Framework for Country Capacity Development
For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Align efforts to reduce gaps

Health Data Science

Appropriate Informatics Approach

Human Capacity

Desired Impact

Reliable Data to Results

Sustainable Approach

For 5th High Level Forum on United Nations
29 November 2017 | Mexico City, Mexico
Key Messages

• Integration of geospatial data to health systems strengthening efforts shall be more widely practiced in the context One Health, SDG 2030 and UHC.

• At national-level, legal mandate is essential for closer collaboration between Ministry of Health and other relevant ministries and space agencies to leverage the benefits of geospatial data for health gains.
Thank you