EO and RS Data for Public Health

Strengthening national capacities for utilizing earth observation and remote sensing data together with routine health systems data to advance national health-related SDG targets

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World Health Organization

Presentation prepared for
GEO Health Community of Practice Meeting
Tuesday, October 24, 2017 - 1:00 to 5:00 pm
Ronald Reagan Building and International Trade Center 1300 Pennsylvania Ave NW, Washington, D.C.
ROOM Meridian B
Presentation Outline

1. Contextualizing Public Health and Space Science

2. Examples of use of space science for public health

3. Need for a framework for use of space science for public health at national-level
Key Message

• National policy framework is needed for use of the earth observation and remote sensing data together with routine health data to advance health-related SDG goals at national and sub-national levels.

• National ownership, inter-sectoral collaboration, technical infrastructure, competent workforce and adequate finances are essential to advance the use of EO and RS data for Public Health.
World Health Organization

Specialized Agency of the United Nations
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
Relevant Documents for Discussion
Space Science and Public Health

Special report of the Inter-Agency Meeting on Outer Space Activities on the use of space science and technology within the United Nations system for global health

UN Document: A/AC.105/1091
30 April 2015
Space Science and Public Health

Report on the meeting on the applications of space science and technology for public health organized by the World Health Organization and the Office for Outer Space Affairs

UN Document: A/AC.105/1099
29 October 2015
Space Science and Public Health

Report on the UN/WHO/Switzerland Conference of Strengthening Space Science for Global Health

UN Document: A/AC.105/1161
18 September 2017
One Health

the interconnectedness of human health, animal health and the ecosystem
HEALTH IN THE SDG ERA

3 GOOD HEALTH AND WELL-BEING

ENSURE HEALTHY LIVES AND PROMOTE WELL-BEING FOR ALL AT ALL AGES

World Health Organization
WWW.WHO.INT/SDGS
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/
## SDG and Space Science for Health*

<table>
<thead>
<tr>
<th>SDG</th>
<th>SPACE SCIENCE AND HEALTH RELEVANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: No Poverty</td>
<td>Prioritizing the health needs of the poor</td>
</tr>
<tr>
<td>2: Zero Hunger</td>
<td>Addressing the causes and consequences of all forms of malnutrition</td>
</tr>
<tr>
<td>6: Clean water and sanitation</td>
<td>Preventing diseases through safe water and sanitation for all</td>
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<tr>
<td>10: Reduced inequalities</td>
<td>Ensuring equitable access to health services through Universal Health Coverage Based on stronger primary care</td>
</tr>
<tr>
<td>13 Climate Action</td>
<td>Protecting health from climate risks, and promoting health through low-carbon development</td>
</tr>
<tr>
<td>14: Life below water</td>
<td>Supporting the restoration of fish stocks to improve safe and diversified healthy diets</td>
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<tr>
<td>15: Life on land</td>
<td>Promoting health and preventing diseases through healthy natural environments</td>
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</tbody>
</table>

*Example; not an exhaustive list
Relevance of EO data to SDG for Health

Leveraging benefits of space science, geospatial data for advancing health agenda
Underpinnings

• Need to understand the current needs of healthcare and public health

• Need to understand the relevance of Space science and technology to overall health systems strengthening efforts

• Need to match appropriate public health and health services delivery needs to innovative space science and technology solutions
Cross sectional View of Relevance of Space Science to Public Health
**Potential Areas of Collaboration**

*Example of mapping priorities, 2015*

<table>
<thead>
<tr>
<th>WHO Global Health Priorities</th>
<th>Shared Interest</th>
<th>Current Applicable Technology</th>
<th>Future Applicable Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP 3: Addressing the challenge of noncommunicable diseases.</td>
<td><strong>Ageing:</strong></td>
<td>CSA: None</td>
<td>CSA: SHARE initiative to bring together international community of space and aging to work together.</td>
</tr>
<tr>
<td>WHO Global NCD Action Plan.</td>
<td>Muscle loss, bone loss, neurovestibular, vision impacts</td>
<td>ESA: Human Health related studies in ELIPS programme, including human physiology, biology &amp; animal experiments; flight &amp; ground JAXA: Joint research on the aging and space physiology issue for the wellbeings of the society</td>
<td>CSA: Research: various areas</td>
</tr>
<tr>
<td>New or enhanced therapies for non-communicable diseases emphasizing ageing populations (typically multimorbid and frail)</td>
<td></td>
<td>NASA: Neurocognitive test battery NASA: Non-pharmaceutical interventions for osteoporosis NASA: Vitamin D and Omega-3 fatty acid ROSCOSMOS: A treatment for cardio-respiratory diseases with warmed-up oxygen-helium mixtures ROSCOSMOS: Technologies for neuro-rehabilitation for stroke and Parkinson patients like Corrigent suit, Regent suit, KORVIT, and an IMMERSION FACILITY ROSCOSMOS: High technological training machines for the testing, training and rehabilitation of people of different physical capacity ROSCOSMOS: Foot supporting zone stimulation device adapted for the elderly</td>
<td>ESA: European Life and Physical Science Research Platform (ELIPS) offering a programme framework for project incubation, coordination and and experimental platform opportunities JAXA: Series of pamphlets for outreach e.g. exercise, sleep, nutrition NASA: Freeze-dried or pouch &quot;super foods&quot; (2018) NASA: Non-invasive intracranial pressure monitor (2018) ROSCOSMOS: The conception of physical health centers ROSCOSMOS: New methods of gravitation therapy on the basis of short radius centrifuge ROSCOSMOS: Probiotics (microorganisms reviving the normal microflora of the human organism)</td>
</tr>
</tbody>
</table>
Ground-based data combined with Earth Observation and Geospatial Data

Integration of data

Digital Elevation Model (DEM):

Water Resource Map

Village or area of interest

Population Data (from multiple sources)

Water accessibility

Water resources and potential source of outbreak

Areas where population resides

Geo-tagging of data for area specific rapid response

Modified after - Source: Rifat Hossain, WHO, 2015
WHO’s Areas of Interest
Space Science and Public Health

• Area 1: Space science and technology for health surveillance and intelligence [HSS]
• Area 2: Space science and technology for health emergency response [HE]
• Area 3: Shaping the research agenda on benefits of space science and technology to public health [UHC]
Data for evidence-informed decision-making
Health Information System Landscape

A Set of Complex Sub Systems

HIS Sub Systems

- Monitoring
- Evaluation
- Research

Data Collection
Forms & Methods

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

- Information Services

- Data Warehouse

- Policy
- Resources
- Processes

Financial Systems

Statistical Systems

Extract, transform and load data into warehouse

Common health-relevant data sources

- Censuses
- Civil Registration
- Population Surveys
- Individual Records
- Earth Observation Data
- Resource Records
- Service Records

Health system data generally found at Health Ministries
Health-relevant earth observation data generally found outside Health Ministries

Population-based
Institution-based
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
(Thermal Infrared Radiances)
Sea Ice Concentration
Sea Ice
Snow Cover
Snow WaterEquivalent
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>
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</thead>
<tbody>
<tr>
<td>GIS with shape files, base maps and commonly used layers</td>
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<tr>
<td>National public assets data</td>
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<tr>
<td>(Airport locations, transportation hubs, Road network maps)</td>
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<tr>
<td>Satellite Imagery</td>
<td>List of donor and partner agencies</td>
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<tr>
<td>(various types and resolutions)</td>
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<tr>
<td>Essential medicines list</td>
<td>Health workforce data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(all types and levels)</td>
<td>(all cadre)</td>
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<tr>
<td>Health facilities list</td>
<td>Supply-chain information</td>
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<tr>
<td></td>
<td>Other context-specific data</td>
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<tr>
<td>Data from Routine Health Information Systems</td>
<td>Subject-specific financial Data</td>
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<tr>
<td>(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)</td>
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<td>Complete list of diseases, health conditions</td>
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<td>List of donor and partner agencies</td>
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<td>Essential medical devices list</td>
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<td>Other context-specific data</td>
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<td>Other remotely sensed data</td>
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<tr>
<td>(temperature, precipitation, terrain and topology)</td>
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<tr>
<td>Country-specific population data</td>
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<tr>
<td>(national/sub-national level; projections, census, actual)</td>
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</table>
EO and Public Health

Examples of use
Topographic map from ALOS is useful for many countries. Road network is essential to deliver vaccines and to visit medical facilities.
Example of MODIS Satellite

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

Source: JAXA, 2014
Mapping WASH and NTDs...hotspot analyses
Tracking of spread of animal born diseases:
Small Animal Tracking from ISS: DLR ICARUS Project

Source: Dr Hatton, ESA 2015
Polio eradication project: Locating sample sites on the satellite images and tracking over time using JAXA’s 5-m resolution DEM data
Locating health facilities using space-based technologies:
Mapping of health facilities
JAXA’s ALOS 3-D mapping capacity
one of the most accurate vertical 5m resolution map
Big data
Examples of big datasets

- Details and location of telephone call logs
- Daily global airline passengers manifest
- Hourly mean temperature of all cities of the world
- Hospital admissions and discharges around the world
- Hourly weather data
- Monthly projection of populations worldwide
analysis and use of rapidly collected

extremely large volumes of

both structured and unstructured electronic data

through multiple data sources

to answer complex questions

that are ordinarily cannot be answered using single datasets
Big data science and data for decision-making

...large scale pattern recognition are often hard to recognize or unseen unless combined by various data types...
Need for a Policy Framework
Strengthening national capacities for utilizing satellite-based earth observation data to advance national health-related SDG targets

A Conceptual Policy 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 data use technical capacities and capabilities

Emerging EO data use technical capacities and capabilities

Policy environment for EO and RS data use is emerging

Policy environment for EO and RS data use is established

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

Beginning of penetration of digital health infrastructure and computing environment

Level = National Readiness for utilizing EO and RS Data in combination with routine health systems data

Level 1: Experimentation
Level 2: Early adoption
Level 3: Developing and building up capacity
Level 4: Scaling up routine use

Strengthening digital health enabled environment for big data analytics

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

Strengthening infrastructure, make the case for digital health environment
Multi-sectoral engagement

Examples of Partners to Advance Space Science and Public Health

- Ministry of Health
- Ministry of Telecommunications
- 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.
GEO XIV PLENARY – INSIGHT FOR A CHANGING WORLD
Washington, DC – USA – 24 October 2017

Conceptual Framework for Country Capacity Development
For utilizing EO, RS, and routine health data to advance 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
Conceptual Framework for Country Capacity Development
For utilizing EO, RS, and routine health data to advance 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 EO, RS, and routine health data to advance health-related SDG targets

Align efforts to reduce gaps

- Health Data Science
- Appropriate EO and RS Approach
- Human Capacity

Desired Impact
Reliable Data to Results
Sustainable Approach
Key Message

• National policy framework is needed for use of the earth observation and remote sensing data together with routine health data to advance health-related SDG goals at national and sub-national levels.

• National ownership, inter-sectoral collaboration, technical infrastructure, competent workforce and adequate finances are essential to advance the use of EO and RS data for Public Health.