Space Science and Technology for Advancing Health-related SDGs

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Key Messages

- National mandate is needed for full adoption of space science and technologies 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 for full adoption of space science and technologies in health sector.

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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

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World Health Assembly
the decision-making body of WHO

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One Health

the interconnectedness of human health, animal health and the ecosystem

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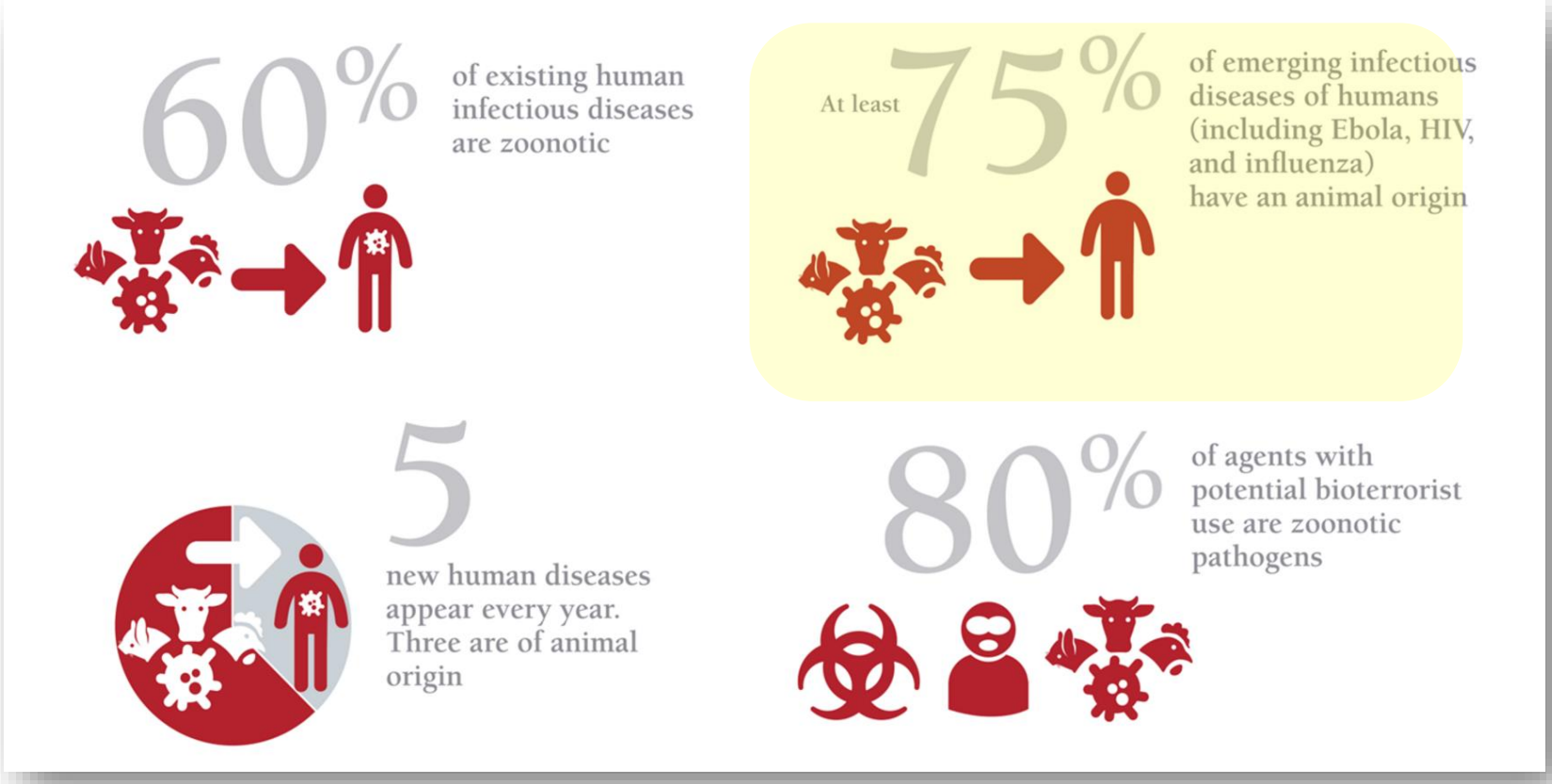
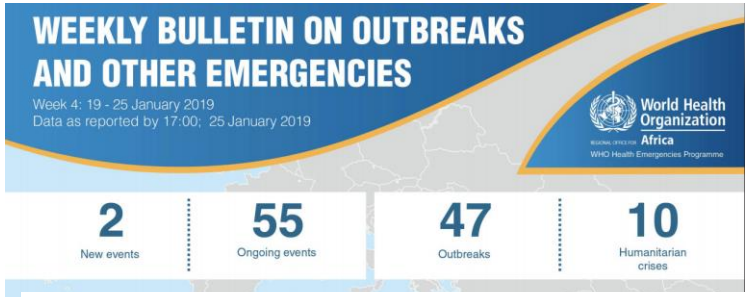
One Health

Source: OIE, 2018; http://www.oie.int/for-the-media/onehealth/

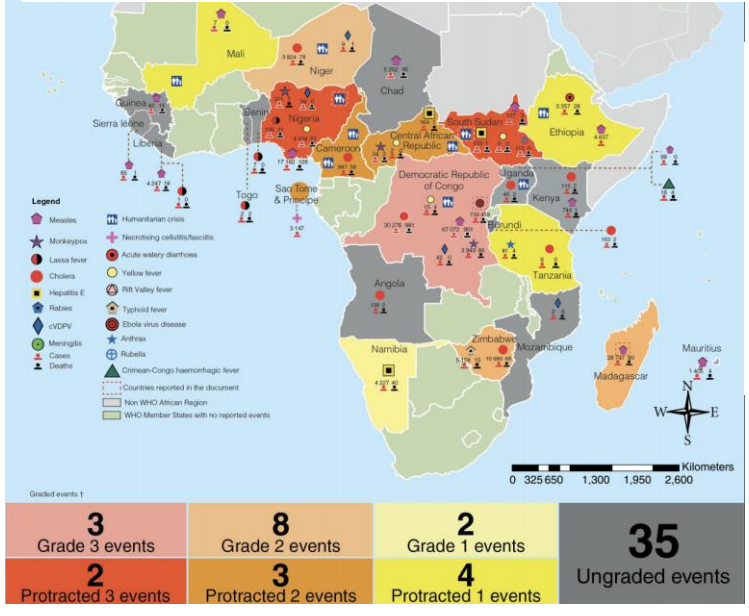
One Health



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



Outbreaks and Emergencies Bulletin, Week 04: 19 - 25 January 2019



- Ebola virus disease in the Democratic Republic of the Congo
- Measles in Madagascar
- Humanitarian crisis in Nigeria
- Humanitarian crisis in South Sudan.

Week 04: 19 - 25 January 2019

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Relevance of Space Science and Technologies to health-related SDGs

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Space Science and Public Health

- Area 1: Space science and technology for epidemic intelligence
- Area 2: Space science and technology Health Emergencies
- Area 3: Shaping the research agenda on Benefits of space science and technology to pubic health

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

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Cross-sectional View of Relevance of Space Science to Public Health


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE AND JUSTICE
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

HEALTH IN THE SDG ERA

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Example of Space Science and Technologies Relevant to Health Sector

WHO Global Health Priorities	Shared Interest	Current Applicable Techology	Future Appliciable Technology
LP 5: Increasing access to essential, high-quality and affordable medical products (medicines, vaccines, diagnostics and other health technologies). -- Supporting UHC -- Monitoring and use of information -- Access to medicines for noncommunicable diseases -- Rational use of medicines antimicrobal resistance -- Access to medicines for HIV/AIDS, TBC, malaria, reprod/mat/child health -- Innovation & local production of medicines	In situ diagnostics and products Telemedicine Longer shelf life of pharmaceuticals	CSA: NeuroArm surgical robot that can operate inside an magnetic resonance imaging machine for e.g. brain surgery making inoperable brain tumours become operable; very expensive but shows potential of what can be done; a surgical robot for pediatric surgery is in development ESA: None JAXA: Share information on the devices used for stress monitoring JAXA: 24-hour ECG for biological or circadian rhythms and heart rate variability in frequency domain JAXA: Actigaphy to monitor physical activity, e.g. for assessing sleep quality NASA: Long-term efficacy tests across a basic medical kit of about 80 major medicines ROSCOSMOS: CARDIOSON contact-less recording of physiological signals during sleeping and ECOSAN-TM with the translation of physiologycal signals to a doctor	CSA: Advanced Crew Medical Systems includes remote health monitoring, biosensor devices and textiles, e.g. physiological monitor "Astroskin" CSA: Bioanalysis and Biodiagnostics CSA: Research: Looking for biomarkers of disease; data-mining ESA: None JAXA: None NASA: Infrared machine to measure pharmaceutical potency (2018) ROSCOSMOS: New devices on the basis of current space prototypes for the effective diagnostic of cardio-vascular system disfunctions (with the three dimensional ballisticardiography, dispersive mapping, etc.) ROSCOSMOS: Contactless recording of physiological signals during sleeping with signal transmission

Ultimately, technology needs to help solve health problems

Example applications of space science and technologies to public health

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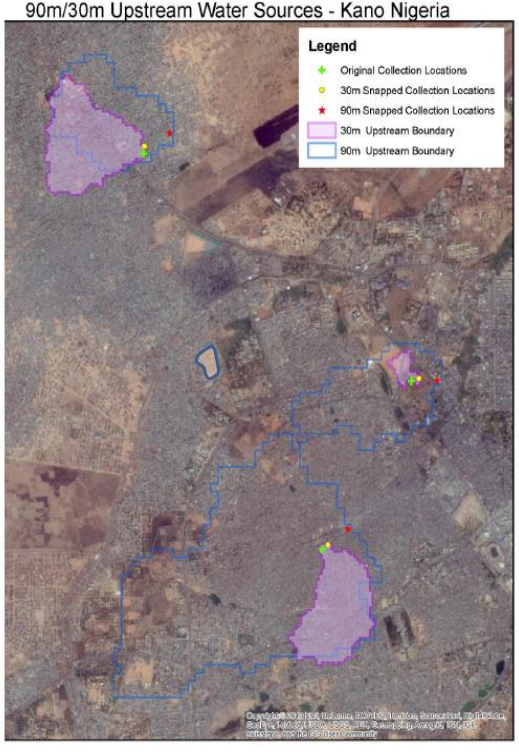
WHO Polio eradication project: Locating sample sites on the satellite images and tracking over time using JAXA's 5-m resolution DEM data

Slide courtesy: Jason Hutton, ESA, 2018



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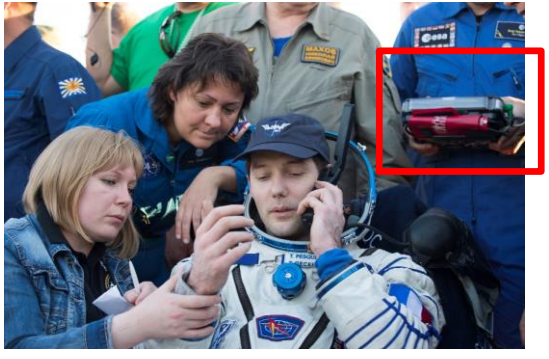
B-Life (Light Fieldable laboratory for Emergencies)
Developed through ESA's Integrated Applications Programme

Integrates Satellite Telecoms, Earth Observation and GNSS Capabilities with field laboratory Deployed in Guinea during 2014-2015 Ebola outbreak

Slide courtesy: Jason Hutton, ESA, 2018

AMAZON Project (TEMPUS)
Developed through ESA's Integrated Applications Programme

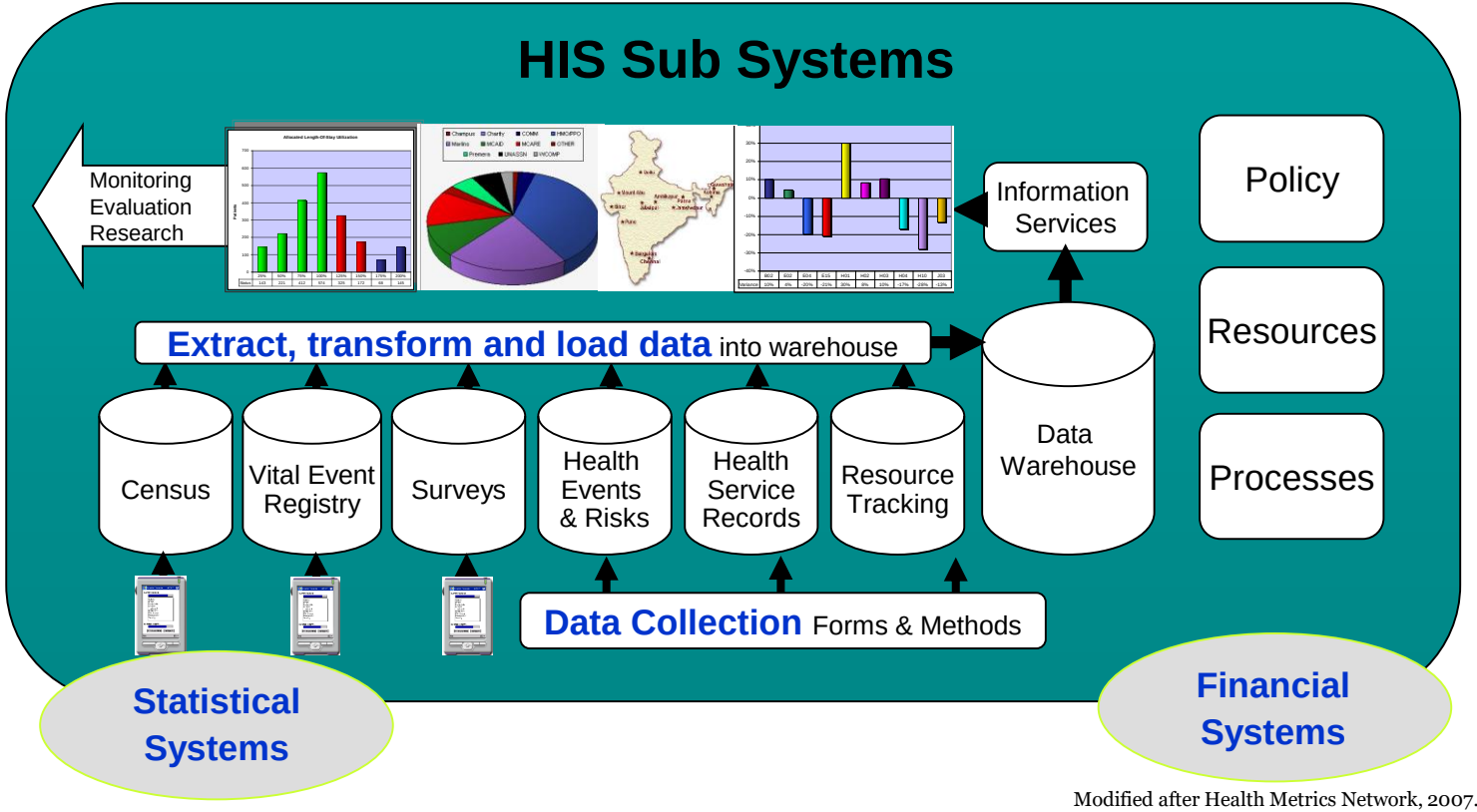
Field diagnostic device, enhanced with telemedicine and GNSS locatisation. Commercially available as Tempus device



Slide courtesy: Jason Hutton, ESA, 2018

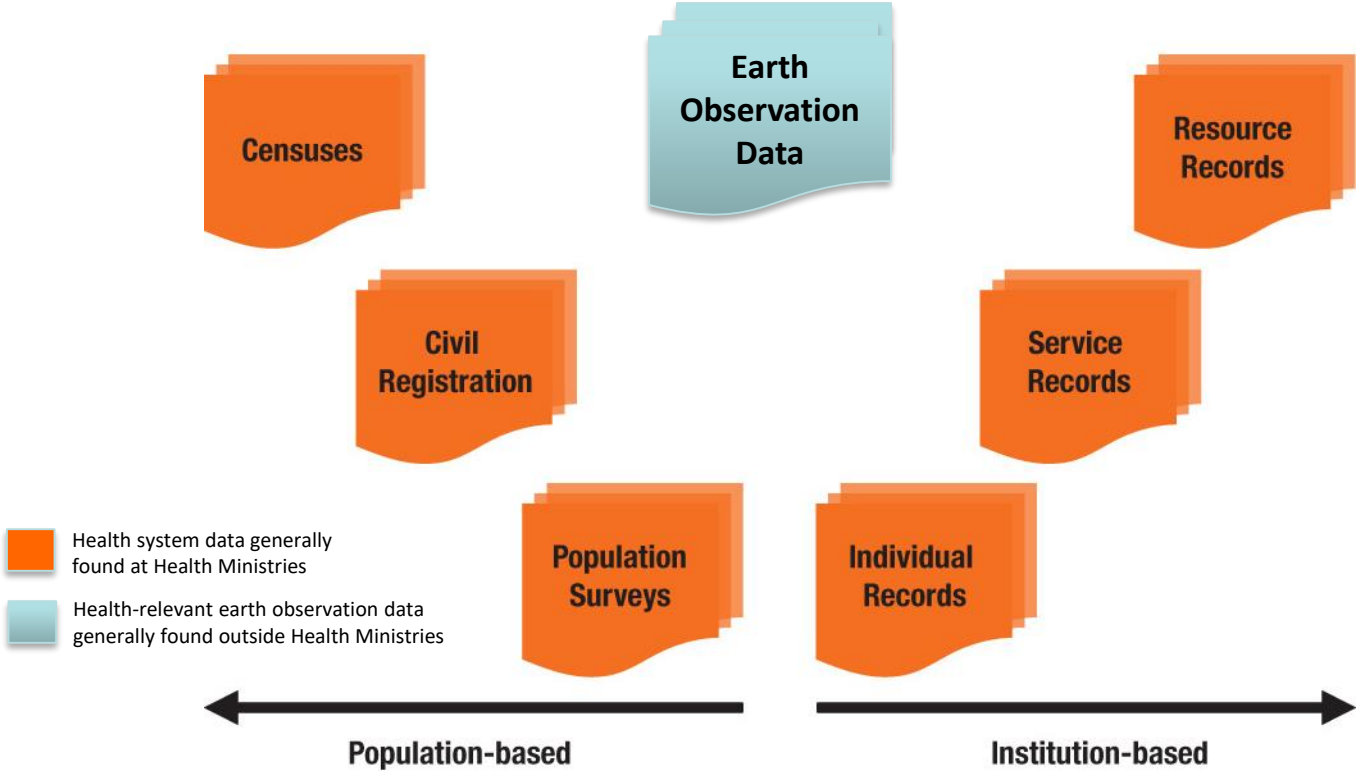
Health Information System Landscape

A Set of Complex Sub Systems



Modified after Health Metrics Network, 2007.

Common health-relevant data sources



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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 Water Equivalent
Soil Moisture
Sulfur Dioxide
Temperature
Total Column Ozone and Aerosol Index
Total Precipitable Water
Water Vapor

Source: NASA, 2017. https://earthdata.nasa.gov/earth-observation-data/near-real-time/download-nrt-data

Examples of potential focus areas identified as part of the ESA-WHO Cooperation

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Earth Observation Data and Products

ESA Space Capability

Earth observation data from a wide range of ESA Developed Earth Observation Satellite Missions

- Scientific (Earth Explorers),
- Sentinels (EU Copernicus)
- MetOp (Eumetsat)

EO for SDG

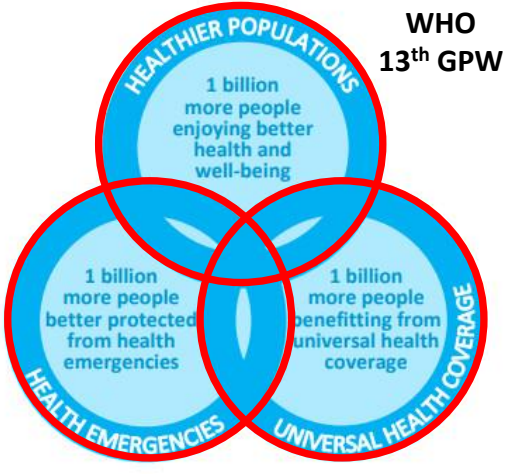
Use of EO data in implementation of Official Development Assistance (ODA) projects, source of environmental information for environmental safeguard, monitoring and evaluation

Integration of EO data in measuring and monitoring of SDG targets with UN Statistical Offices and National Statistical Offices

Health SDG Relevant Focus areas;

- **Water mapping => Accessibility, quality, disease vectors**
- **Climate change and determinants of health**
- **Disaster / epidemic response (link with IDC)**

WHO 13th GPW



Operations Planning and Big Data Analytics

ESA Space Capability

- Spacecraft Operations: Tracking & Control of Spacecraft, planning of operations
- Innovative Technology solutions for decision making

Potential Applications to Health

- **Predictive Analytics, data driven modelling and forecasting**
  - **Early detection of disease outbreaks, models of evolution of epidemics, "what if" analysis of different scenarios & preventative measures**
- **Artificial Intelligence Planning & Scheduling of Health services delivery**
  - **Optimal allocation of resources & sequences for service delivery**
  - **Simulated feasibility analysis of (*what-if*) scenarios of new services**
  - **Health Emergency process management & decision support**

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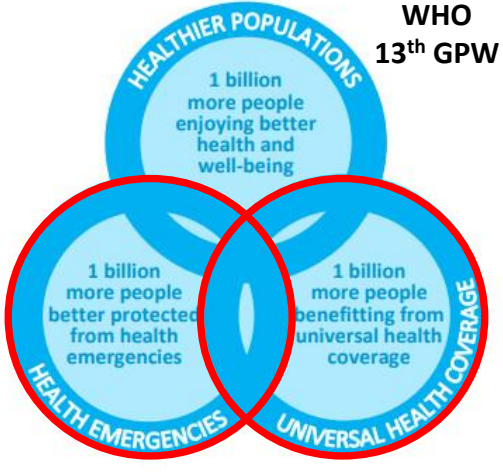

Space Technology and Services

ESA Space Capability

- Supporting development of projects which utilise space technologies and capabilities for terrestrial applications
- Transfer of technology developed for space applications for terrestrial use

Example Health Applications

- **eHealth & Telemedicine (50% of ESA's Health Projects)**
- **Deployable lab / midi lab on table technology**
- **Environment – water & air monitoring**
- **Water treatment technologies**

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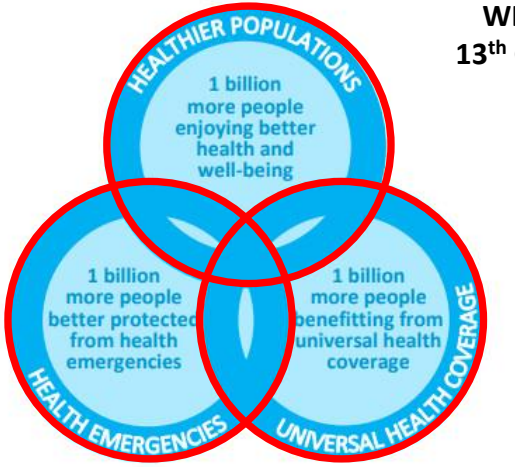

Human Spaceflight Research, Applications and Technology

Space Capability

- Health relevant research in space and analogue platforms
- Living & working in hostile environments and development of countermeasures
- Diagnostic technology and emergency / autonomous medical care for space crew

Terrestrial Health Application of Human Spaceflight research findings & technology

- **Medical and biology research – applicants to terrestrial health**
- **Water treatment, food production in compact environment / limited resources**

Technology & Knowledge Spin in / Spin out for Human Space Exploration

- **Emergency medical care, Monitoring of persons in isolated environments, with remote or autonomous decision making for medical care**
- **Medical diagnostics technologies and processes**

Healthy Living / Optimizing use of Physical Exercise

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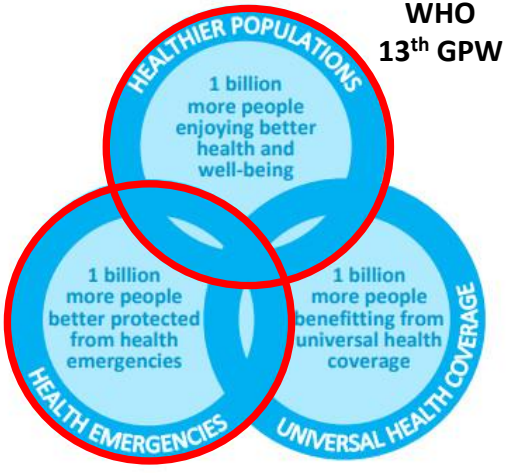

Education and Capacity Building

Space Capability

- Full portfolio of ESA space activities
- Broad range of education activities at many different levels associated with projects and programme
- Inspiration and fostering cooperation

Education Activities linked to Health relevant SDG's

SDG 3 - Ensure healthy lives and promote well-being for all at all ages Mission X – train like an astronaut

SDG 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all --> ESA Education runs a continuous teacher training programme at school level and student training programme at university level

SDG 5 - Achieve gender equity and empower all women and girls; Gender equity/breaking of stereotypes is a cultural aspect we promote through all ESA Education initiatives

SDG 6 - Ensure availability and sustainable management of water and sanitation for all; new European school initiative about Exploration, including water recycling

SDG 13 - Take urgent action to combat climate change and its impacts new European school initiative about Climate Change

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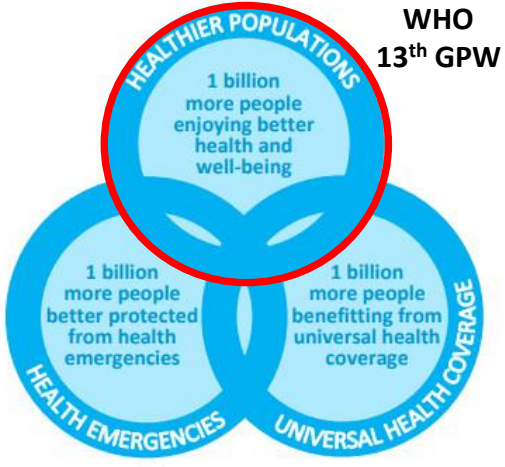

Countries need a framework to Strengthen national capacities for utilizing space science and technologies to advance national health-related SDG 3 targets

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Components of the Framework

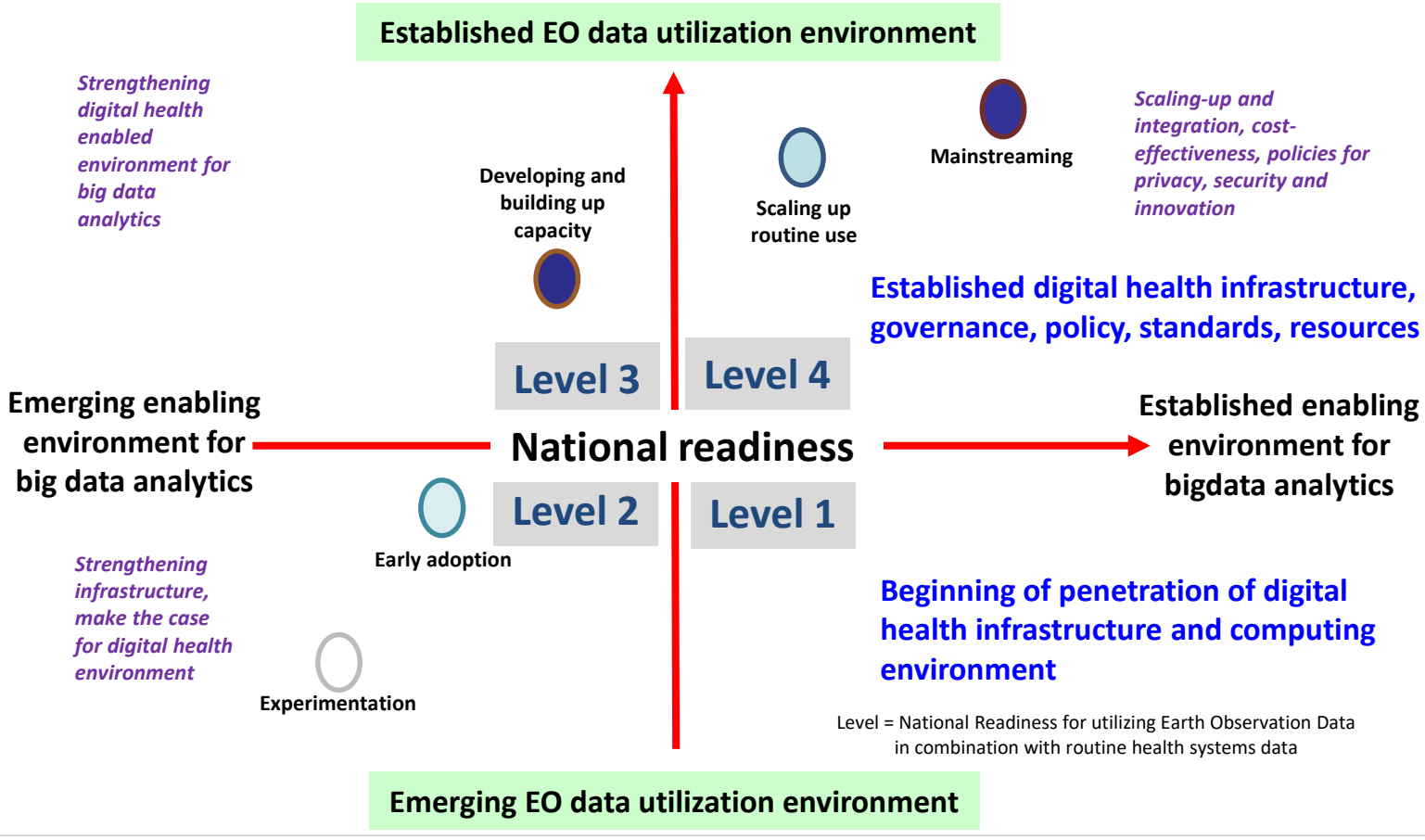
1. **National readiness** for using earth observation data in conjunction with routine health systems data

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



Conceptual Framework for Country Capacity Development

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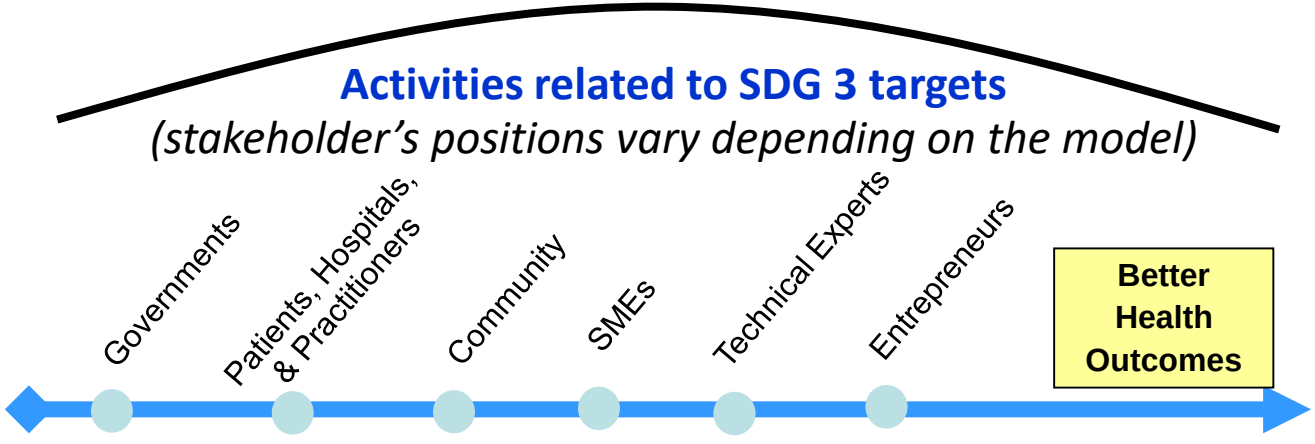
Align Stakeholders

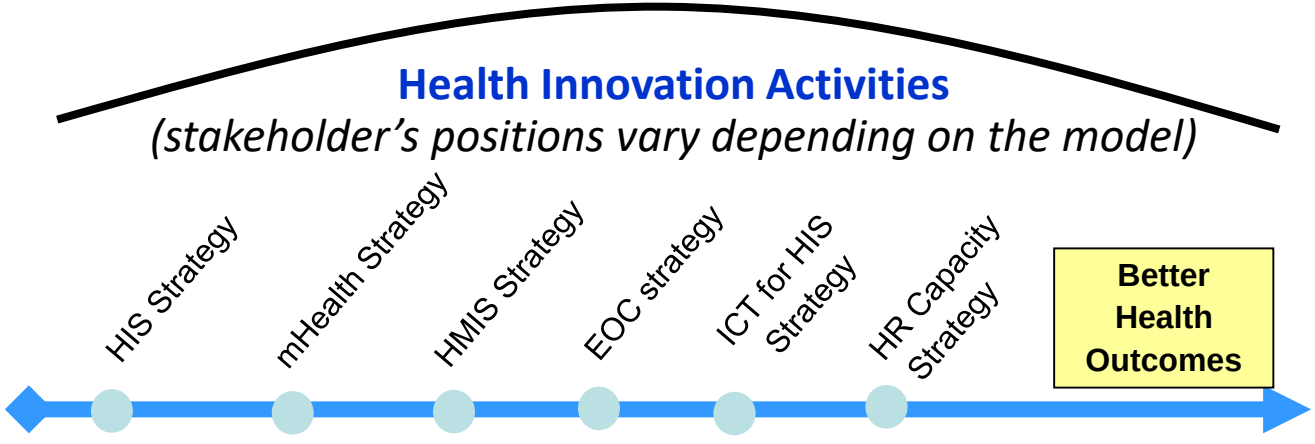


Value Chain of Solutions
driven by Public Private Partnerships

Conceptual Framework for Country Capacity Development

For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Align Strategies

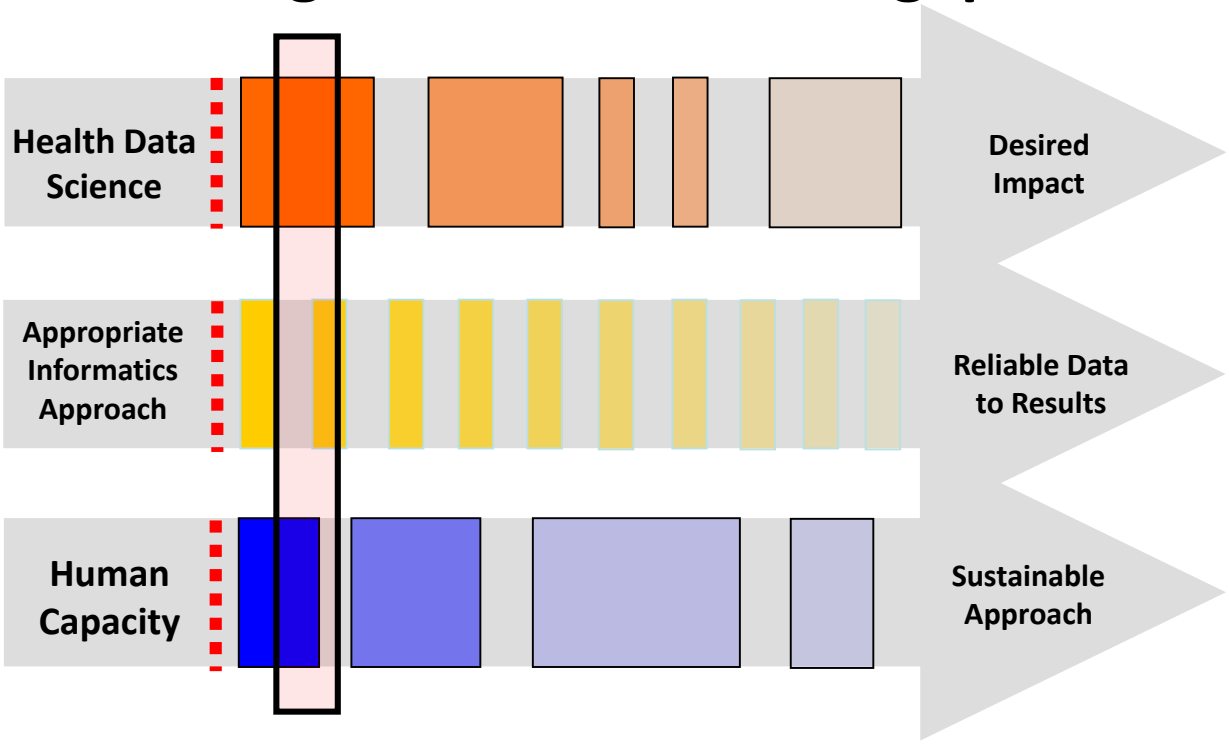


Value Chain of Solutions
driven by Public Private Partnerships

Conceptual Framework for Country Capacity Development

For utilizing Satellite-based Earth Observation Data in advancing health-related SDG targets

Align efforts to reduce gaps



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Thank you

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