Health Spatial Information Framework White Paper

Table of Contents

1. Summary 4
1.1. Document contributor contact points 4
1.2. Foreword 5
2. Introduction 6
3. Initiatives 8
3.1. GEO Task US-09-01a Critical Earth Observations Priorities for Health Societal Benefit Area: Infectious 8
3.2. EO4HEALTH 9
3.3. EO2 Heaven 9
3.4. CGDI 9
3.5. INSPIRE Human Health and Safety Data Specifications 9
3.6. GEO-DARMA 11
3.7. LODGD 11
3.8. IRDR-DATA 11
3.9. ECCMA ePROP 11
3.10. MeSH 11
3.11. SNOMED 12
3.12. UMLS 12
3.13. UNCAP 12
3.14. AGEWELL 12
4. Application Areas 13
4.1. Climate-Health 13
4.2. Healthy Aging 14
4.3. Global Indicators 14
4.4. Health in the Smart City 17
4.5. Scenarios 18
5. Data Considerations and Related Recommendations 19
5.1. Conceptual model recommendations 19
5.2. Functional areas recommendations 19
5.3. Data recommendations 20
5.4. Data Requirements 20
6. Architecture Framework 24
Appendix A: Revision History 25
Appendix B: Bibliography 27

Publication Date: YYYY-MM-DD

Approval Date: YYYY-MM-DD

Posted Date: YYYY-MM-DD

Reference number of this document: OGC XX-XXX

Reference URL for this document: http://www.opengis.net/doc/-ID

Category: White Paper

Editor: Eddie Oldfield, Luis Bermudez

Title: Health Spatial Information Framework White Paper

OGC White Paper

COPYRIGHT

WARNING

This document is not an OGC Standard. This document is an OGC White Paper and is not an official position of the OGC membership. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an OGC Standard. However, the discussions in this document could very well lead to the definition of OGC Standards.

party, you agree that LICENSOR, in its sole discretion, may terminate this license without any compensation or liability to you, your licensees or any other party. You agree upon termination of any kind to destroy or cause to be destroyed the Intellectual Property together with all copies in any form, whether held by you or by any third party.

Except as contained in this notice, the name of LICENSOR or of any other holder of a copyright in all or part of the Intellectual Property shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Intellectual Property without prior written authorization of LICENSOR or such copyright holder. LICENSOR is and shall at all times be the sole entity that may authorize you or any third party to use certification marks, trademarks or other special designations to indicate compliance with any LICENSOR standards or specifications.

This Agreement is governed by the laws of the Commonwealth of Massachusetts. The application to this Agreement of the United Nations Convention on Contracts for the International Sale of Goods is hereby expressly excluded. In the event any provision of this Agreement shall be deemed unenforceable, void or invalid, such provision shall be modified so as to make it valid and enforceable, and as so modified the entire Agreement shall remain in full force and effect. No decision, action or inaction by LICENSOR shall be construed to be a waiver of any rights or remedies available to it.

None of the Intellectual Property or underlying information or technology may be downloaded or otherwise exported or reexported in violation of U.S. export laws and regulations. In addition, you are responsible for complying with any local laws in your jurisdiction which may impact your right to import, export or use the Intellectual Property, and you represent that you have complied with any regulations or registration procedures required by applicable law to make this license enforceable.

Chapter 1. Summary

This Health Spatial Information Framework white paper provides a discussion about the exchange, integration, analysis, and visualization of health and non-health data to support health applications. It identifies opportunities to advance the OGC Standards towards building a framework to support Health Spatial Data Infrastructures (SDIs).

Developing a Health Spatial Information Framework based on open standards will help health data users and other stakeholders in the following ways:

- **Solution Providers** - to understand market needs and add value to services;
- **Market Participants** - to understand where OGC standards can be applied to support improved health outcomes;
- **Government and Institutes** - to understand market priorities and to design health-oriented SDIs;
- **Standards Organizations** - to understand opportunities to develop or improve standards to support health applications;
- **Researchers** - to have a foundation of elements for advancing research on SDIs and health-related applications using OGC Standards;
- **Health Systems** - to understand how such a framework could contribute to clinician point-of-care decision support and be leveraged to improve outcomes.

The paper builds on contributions from OGC Health DWG members and is informed by OGC Health DWG sessions from 2012-2017, including Summits in 2016 and 2017. Four key application areas are addressed, providing a broad scope of market requirements and functional areas:

- Climate-Health
- Healthy Aging
- Global Indicators
- Health in the Smart City

1.1. Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Name	Organization
Luis Bermudez	OGC
Eddie Oldfield	Spatial Quest

Name	Organization
Scott Serich	OGC

Table 1. Contacts

1.2. Foreword

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

Chapter 2. Introduction

One hundred and fifty years ago, John Snow demonstrated the value of spatial relationships by combining cholera death and water pump locations to predict the development of infectious disease outbreaks. Today, GIS, computing, modeling, statistics, sensors, geospatial data and OGC web service standards are enabling powerful spatial analysis to support health and epidemiological research. However there is not a documented framework that provides an architecture and interfaces to support a health spatial data infrastructure.

Discussions around the framework has been advanced by the OGC Health Domain Working Group (Health DWG). This DWG convened a Health Summit, during the OGC TC in Dublin in June 2016. Through interviews and discussion, participants indicated that a future state of a Spatial Data Infrastructure would include implementation of more widely accepted interoperability (OGC) standards-based technologies and services, improved privacy and security best practices, and common vocabularies.

Ideas from participants on the climate-health panel coalesced around the need to improve interoperability of geospatial data and web services to facilitate more sophisticated climate-health applications. Ideas from the healthy-aging panel coalesced around the ability of sensor networks to support active and healthy aging, connecting indoor sensors and devices to support clinical records and the wellbeing of patients with cognitive impairments (as an example) - this culminated in the creation of an Active and Healthy Aging Observation and Measurement (AHA O&M) Profile. Ideas from participants on the healthy urban environments panel coalesced around the need for well-defined protocols for using health information in mapping applications while protecting privacy, to better understand interaction between disease and health determinants (including built environment).

Since the Health Summit in 2016, interest continues to be expressed in the potential for OGC standards to support health domain requirements, helping to solve interoperability challenges for integrating health data with non-health data (e.g. social and environmental determinants of health). But disparities remain in the adoption of standards and frameworks to collect, process, store, integrate, visualize, and protect information, especially with complex Big Data scenarios. Health professionals rarely have access to or are not able to use climate and weather data for diagnosing, treating, monitoring, or advising a patient; or to take informed action based on environment and health data mashups, or to determine causal relationships over various spatial and temporal scales. The data challenge includes several aspects: quantity of data, distributed nature of data, the heterogeneity and diversity of the data, the lack of data sharing due to both policy and technology limitations, and difficulties to share across disciplines, organizations, and geographic boundaries.

Health professionals rarely have consistent access to climate and weather data for diagnosing, treating, monitoring, or advising a patient. While it is recognized by the medical community that the environmental factors these data sources represent can impact health outcomes for a wide range of patient conditions (e.g., asthma, allergies, depression, skin conditions, etc.), these data sources not available with the same consistency and accuracy of other health data (e.g., lab results and patient vital signs). This complicates provider efforts to leverage this data to take informed action and to determine causal relationships over various spatial and temporal scales.

The data challenge includes several aspects: quantity of data, consistency of data availability, ability to customize data to meet diverse provider requirements, distributed nature of data, the heterogeneity and diversity of the data, the lack of data sharing due to both policy and technology limitations, and difficulties to share across disciplines, organizations, and geographic boundaries.

Furthermore it is important to look at how geospatial standards are used to support indicators on a spatiotemporal basis to help determine current state and plan for action related to global disparities for health impacts from disasters and climate change. Challenges still remain on spatiotemporal understanding of health impacts (e.g. injury, illness, death) from climate change and environmental health determinants, population vulnerabilities and adaptive capacity, and other possible complex exposures (diets, lifestyles, etc).

It is also worth noting that sometimes making more information available to the public can have unexpected collateral consequences. For example, , identifying cities or neighborhoods with heightened risk to asthma patients could potentially cause real estate valuations in the area to fall.

This white paper, as well as potential future activities to advance the framework, will continue to be discussed at future Health DWG meetings and summits.

This paper first presents and introduction and background, then discusses key application areas, and finally proposes a framework to support Health SDIs. The resulting framework will serve as the basis for agencies around the globe to support regional SDIs and to develop prototype activities under the OGC Innovation Program for further refinement of framework capabilities.

There is also not a defined framework for how to use geospatial data analytics to derive potential solutions to population health challenges. That is a missing link towards which this white paper hopes to serve as a first step.

Chapter 3. Initiatives

The following initiatives (including standards and projects) were investigate for the purpose of extracting patterns and best practices to build the Health Spatial Information Framework.

3.1. GEO Task US-09-01a Critical Earth Observations Priorities for Health Societal Benefit Area: Infectious

Experts under the Group on Earth Observations (GEO) supported the development of a study ([1]) to identify Earth Observations required by communities dealing with Infectious Diseases as part of the Health Societal Benefit Area under Task US-09-01a. They created a database (see Figure Database of Relations of Earth Observation Data and Diseases) to capture the relation between Earth Observations and diseases.

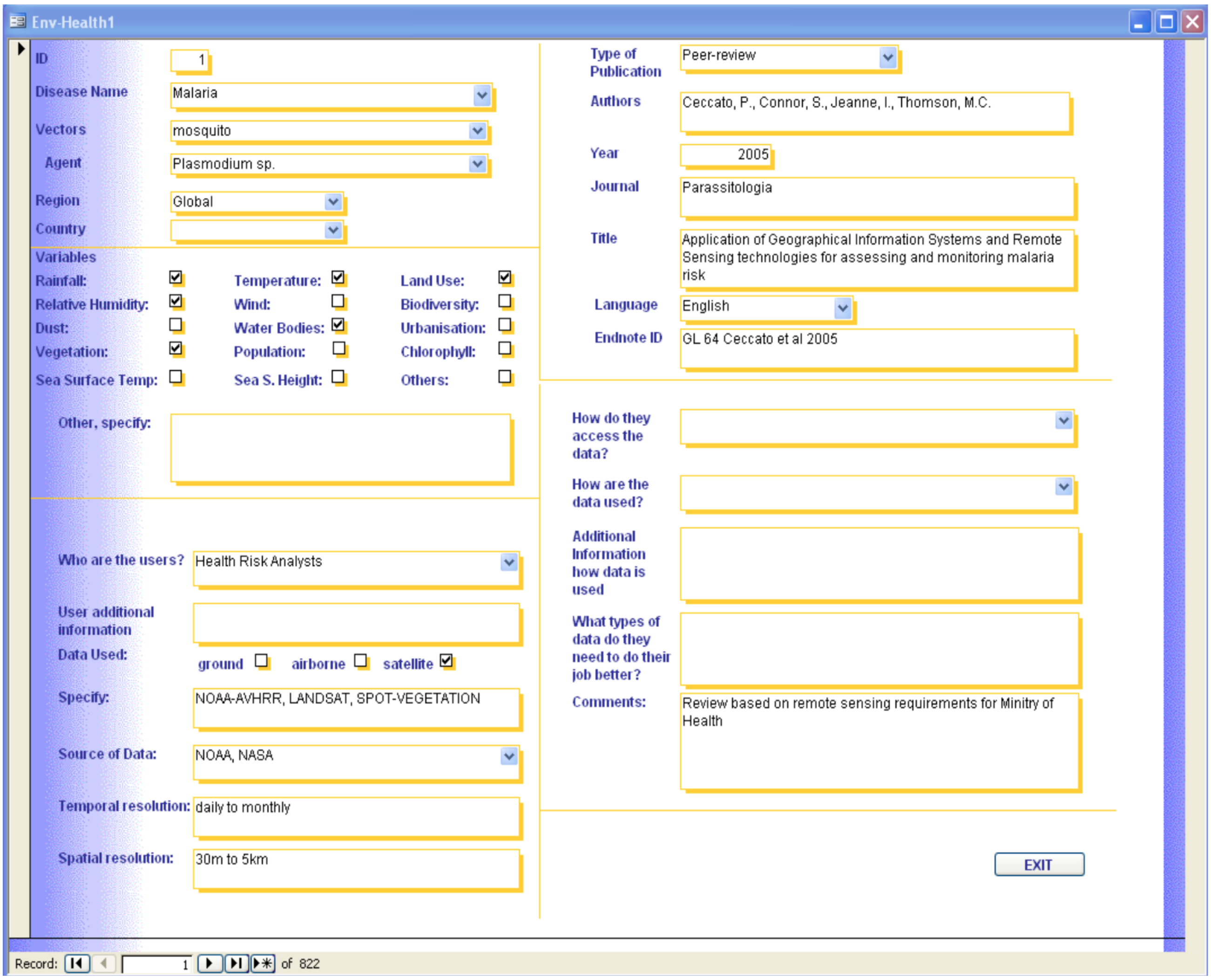

Figure 1. Database of Relations of Earth Observation Data and Diseases

3.2. EO4HEALTH

Earth Observations for Health (EO4HEALTH) is a community activity under the GEO 2017-2019 Work Program. Its goal is the advancement of integrated information systems to reduce environmental health related risks. It focuses on:

- Weather and climate extremes (e.g., heat)
- Water-related illness (e.g., cholera)
- Vector borne disease (e.g., dengue, malaria)

3.3. EO2 Heaven

EO2HEAVEN was funded by European Commission 7th Framework Program to advance better understanding of the complex relationships between environmental changes and their impact on human health. The project advanced a system architecture and developed applications related to changes induced by human activities, with emphasis on atmospheric, river, lake and coastal marine pollution. The project provided recommendations on standards-based Spatial Information Infrastructure (SII) to support research of human exposure and early detection of infections ([2]).

3.4. CGDI

The Canadian Geospatial Data Infrastructure (CGDI) implements a framework for data sharing and data integration by using standard based technologies. It has adopted many specifications addressed by ISO/TC211, OGC, FGDC and W3C in describing, publishing, visualizing, accessing and manipulating geospatial resources, such as Catalog services interface, Web Map Service (WMS), Styled Layer Descriptor (SLD), Web Feature Service (WFS), Web Processing Service (WPS). These services can be chained together to implement complex tasks by the defining of the workflow process, as was done in a pandemic simulation in 2007 funded by GeoConnections and the USGS [need reference to this simulation].

3.5. INSPIRE Human Health and Safety Data Specifications

The Infrastructure for spatial information in Europe has defined the Human Health and Safety theme, including technical guidelines for data specifications ([3]). For example, it provides a conceptual model for the sharing of health data (See figure INSPIRE UML class for health statistical data).

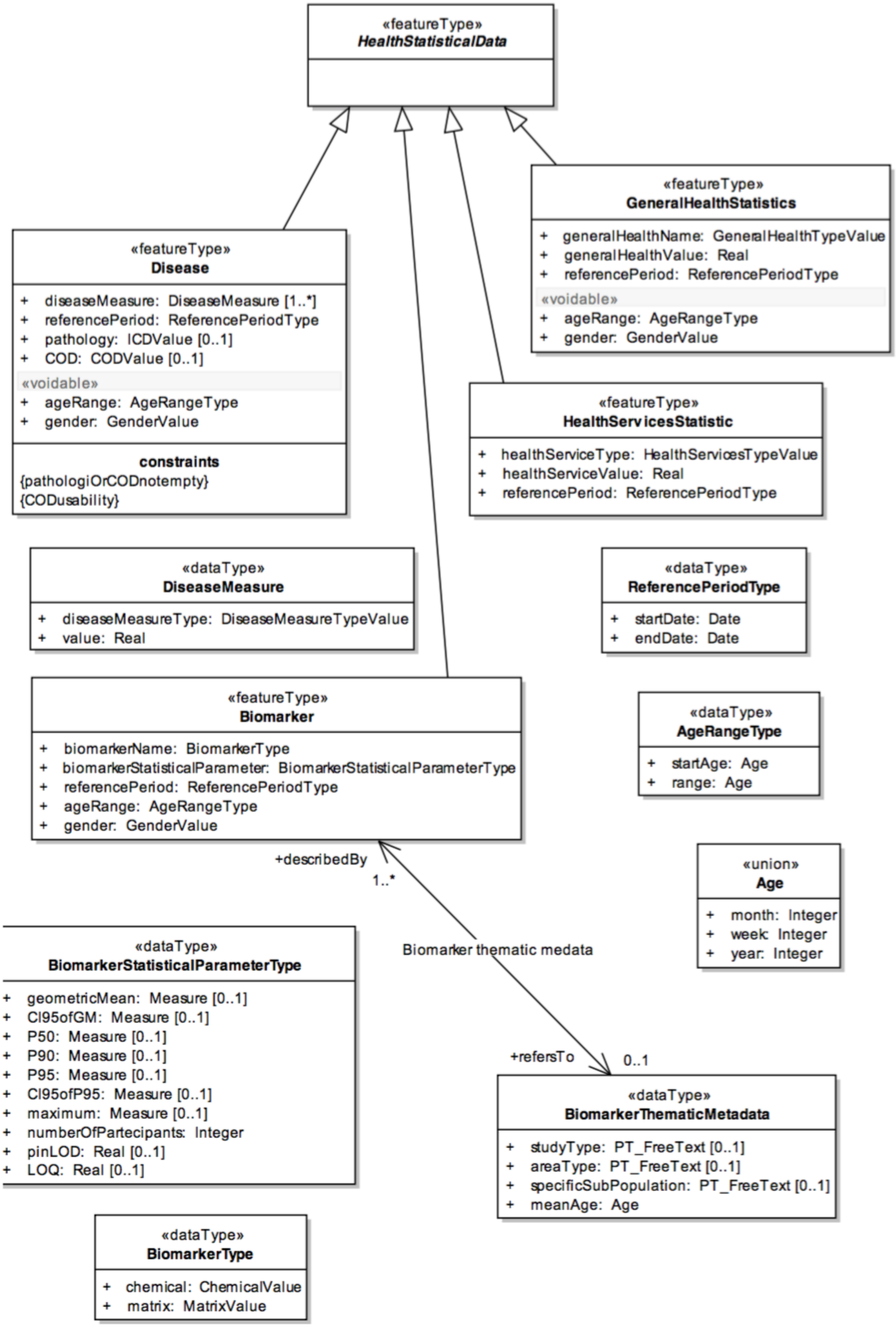

Figure 4: UML class: HealthStatisticalData - Full diagram

Figure 2. INSPIRE UML class for health statistical data

3.6. GEO-DARMA

The Data Access for Risk Management (DARMA) initiative aims to increase the availability and accuracy of risk related information to allow decision-makers to simulate the impact of risk-reduction measures and make informed decisions about risk reduction investment. The type of risk information useful to decision-makers depends on the geographical location, the type of risk affecting the region, the local policies, and more. GEO-DARMA addresses several articles of the Sendai Framework such as articles 24 and 25 that calls for the "promotion and enhancement through International cooperation, including technology transfer, (of) access to and use of non sensitive data, information, as appropriate, communications and geospatial and space-based technologies and related services." GEO-DARMA will define end-to-end solutions that foster use of accurate Earth Observation data risk information products and services for evidence-based decision-making.

3.7. LODGD

The group Linked Open Data for Global Disaster Risk (LODGD), as part of the interdisciplinary Committee on Data for Science and Technology (CODATA), aims to address the challenge of management and integration of disaster-related data for research and policy making. In its first white paper publication ([4]), the group highlighted the importance of data interconnectivity from different scientific disciplines such as hydrology, meteorology, climate, civil engineering, land use, and public health. CODATA is in process of producing a second white paper related to a Next Generation Spatial Data Infrastructure (NG-SDI).

3.8. IRDR-DATA

The Disaster Loss Data (DATA) project, under the umbrella of the Integrated Research on Disaster Risk (IRDR) program, brings together stakeholders from different disciplines and sectors to study issues related to the collection, storage, and dissemination of disaster of loss data,

3.9. ECCMA ePROP

not sure how relevant is this to this paper

3.10. MeSH

The Medical Subject Headings (MeSH) is the US National Library of Medicine’s thesaurus. It provides a controlled vocabulary of terminology useful for indexing and cataloging biomedical and pharmaceutical information.

3.11. SNOMED

The Systematized Nomenclature of Medicine (SNOMED) provides a comprehensive controlled vocabulary for terms related to anatomy, diseases, findings, procedures, microorganisms, substances and other topics. It is used by the U.S. Federal Government systems for the electronic exchange of clinical health information.

3.12. UMLS

The Unified Medical Language System (UMLS) provides controlled vocabularies for biomedical information and health records. Useful applications build with UMLS can enable linking of records (via codes or terms) between doctor's, care centers, pharmacies, and insurance companies.

3.13. UNCAP

can't find this reference

3.14. AGEWELL

can't find this reference

Chapter 4. Application Areas

Development of an information framework requires understanding of the applications that the framework should support. The following application areas are included in this document:

- Climate Health
- Healthy Aging
- Global Indicators
- Health in the Smart City

4.1. Climate-Health

Climate variability can pose significant threats to human health and well-being in the form of higher temperatures, increased extreme weather events, wildfire, decreased air quality, and illnesses transmitted by food, water, and disease carriers such as mosquitoes and ticks. Extreme storms and temperatures can also disrupt the delivery of health services and damage hospitals, clinics, wastewater treatment plants, and other facilities. Climate variability can also impact economic sectors that support health, such as energy, transportation, and agriculture. A Health Spatial Information Framework could help in the development of new ways to monitor, prevent, and respond to climate impacts on human health. Steps taken to prepare for climate impacts can improve health and provide other societal benefits, such as sustainable development, disaster risk reduction, and improvements in quality of life.

Applications arising from a Health Spatial Information Framework could help health authorities publish up-to-date maps showing various dimensions of disease, population health, and environment. Economies of scale can be leveraged when epidemiological research and health planning communities utilize a coordinated system to address inequalities in health care provision, access, and promotion. Applications can be scaled up to support more sophisticated climate-health scenarios, particularly during health emergencies and for pandemic response efforts ([5, 6]).

Research collaboratives such as the Lancet Countdown ([7]) could also inform framework development. The Countdown proposed five thematic working groups:

- Health impacts of climate hazards;
- Health resilience and adaptation;
- Health co-benefits of climate change mitigation;
- Economics and finance; and

- Political and broader engagement.

These working groups, along with associated indicator domains, could be used to provide organizing principles for a health spatial data infrastructure or perhaps even for the overall spatial information framework itself.

4.2. Healthy Aging

Some people are more vulnerable than others to climate impacts on health. Vulnerable populations of concern include children and pregnant women, older adults, those with low income, immigrant groups, indigenous peoples, and some communities of color. In order to address aging populations and to reduce vulnerability, health organizations are increasingly turning to geospatial analysis to assess risk based on location, to prioritize areas for interventions.

Need references

4.3. Global Indicators

Various global initiatives have provided guidance towards global indicators to help monitor the status of health in populations. The initiatives include Sustainable Development Goal developed by the United Nations, the Sendai Framework for Disaster Risk Reduction and the Paris Agreement on Climate Change.

United Nations Sustainable Development Summit - Sustainable Development Goals

At the United Nations Sustainable Development Summit 2015, 193 countries agreed on the Sustainable Development Goals (SDGs). For each goal specific objectives and targets were defined ([8]). The goal related to health is *Goal 3 Good Health and Wellbeing*. The objective of this goal is to "Ensure healthy lives and promote well-being for all at all ages". Thirteen targets and associated indicators were developed by the Interagency and Expert Group on SDG Indicators (IAEG-SDGs).

Indicators for the Sustainable Development Goal 3 **Good Health and Wellbeing

```
   3.1.1 Maternal mortality ratio
   3.1.2 Proportion of births attended by skilled health personnel
   3.2.1 Under-five mortality rate
   3.2.2 Neonatal mortality rate
   3.3.1 Number of new HIV infections per 1,000 uninfected population, by
sex, age and key populations
   3.3.2 Tuberculosis incidence per 100,000 population
   3.3.3 Malaria incidence per 1,000 population
```

```
   3.3.4 Hepatitis B incidence per 100,000 population
   3.3.5 Number of people requiring interventions against neglected tropical
diseases
   3.4.1 Mortality rate attributed to cardiovascular disease, cancer,
diabetes or chronic respiratory disease
   3.4.2 Suicide mortality rate
   3.5.1 Coverage of treatment interventions (pharmacological, psychosocial
and rehabilitation and aftercare services) for substance use disorders
   3.5.2 Harmful use of alcohol, defined according to the national context as
alcohol per capita consumption (aged 15 years and older) within a calendar
year in litres of pure alcohol
   3.6.1 Death rate due to road traffic injuries
   3.7.1 Proportion of women of reproductive age (aged 15-49 years) who have
their need for family planning satisfied with modern methods
   3.7.2 Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000
women in that age group
   3.8.1 Coverage of essential health services (defined as the average
coverage of essential services based on tracer interventions that include
reproductive, maternal, newborn and child health, infectious diseases, non-
communicable diseases and service capacity and access, among the general and
the most disadvantaged population)
   3.8.2 Proportion of population with large household expenditures on health
as a share of total household expenditure or income
   3.9.1 Mortality rate attributed to household and ambient air pollution
   3.9.2 Mortality rate attributed to unsafe water, unsafe sanitation and
lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All
(WASH) services)
   3.9.3 Mortality rate attributed to unintentional poisoning
   3.a.1 Age-standardized prevalence of current tobacco use among persons
aged 15 years and older
   3.b.1 Proportion of the target population covered by all vaccines included
in their national programme
   3.b.2 Total net official development assistance to medical research and
basic health sectors
   3.b.3 Proportion of health facilities that have a core set of relevant
essential medicines available and affordable on a sustainable basis
   3.c.1 Health worker density and distribution
   3.d.1 International Health Regulations (IHR) capacity and health emergency
preparedness
```

There are other health related goals and indicators related to poverty, education, food / nutrition (malnutrition), food supply, water / vector borne disease, mental health, and occupational health and safety.

Each country will be able to measure progress toward achieving the objectives using the indicators. Health indicators at the national and sub-national level consist of data obtained by national health agencies, statistical agencies e.g. census data, and regional health authorities. Lack of availability at the local and regional levels, constraining ability to measure indicators for all regions. There are also challenges for integrating, analyzing, and visualizing indicator data at a sub-national level (at various scales) by countries adopting the indicators due to inconsistencies in data collection.

Sendai Framework for Disaster Risk Reduction

The UN General Assembly Resolution A/RES/71/276 ([9]) endorsed the recommendations of the Open-ended intergovernmental expert Working Group on 2 February 2017. The report recommends indicators for the seven global targets of the Sendai Framework for Disaster Risk Reduction 2015-2030 ([10]. The indicators related to health are as follows:

Sendai Framework Indicators Related to Health

```
- Global target A: Substantially reduce global disaster mortality by 2030,
aiming to lower average per 100,000 global mortality between 2020-2030
compared with 2005-2015.
   - A-1 (compound) Number of deaths and missing persons attributed to
disasters, per 100,000 population.
   - A-2 Number of deaths attributed to disasters, per 100,000 population.

- Global target B: Substantially reduce the number of affected people
globally by 2030, aiming to lower the average global figure per 100,000
between 2020-2030 compared with 2005-2015.
   - B-2 Number of injured or ill people attributed to disasters, per 100,000
population.
   - B-3 Number of people whose damaged dwellings were attributed to
disasters.
   - B-4 Number of people whose destroyed dwellings were attributed to
disasters.
   - B-5 Number of people whose livelihoods were disrupted or destroyed,
attributed to disasters.

- Global target D: Substantially reduce disaster damage to critical
infrastructure and disruption of basic services, among them health and
educational facilities, including through developing their resilience by
2030.
   - D-2 Number of destroyed or damaged health facilities attributed to
disasters.
   - D-7 Number of disruptions to health services attributed to disasters
```

However, the quality of these indicators is constrained by the quality of the data used to generate them ([11]). When high-quality data is accessible, differences in recording can frustrate attempts at aggregation, and even when aggregation is possible, significant subgroup trends can sometimes be masked. As the authors note, the World Health Organization (WHO) Global Reference List of 100 Core Health Indicators is a step toward alignment in reporting.

The Framework and any supporting OGC Innovation Program activities should take advantage of the momentum established by these 100 indicators.

A complementary asset is available from the Global Burden of Disease (GBD) research program. The GBD provides a helpful decision-support tool, the GBD Visualization Hub, particularly with respect to Sendai Framework Global Targets A and B. The Hub is maintained by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington in Seattle, USA. It provides consistent, comparative descriptions of the burden of diseases and injuries (and associated risk factors), including categorization of deaths and disability adjusted live years due to a breadth of causes.

Another complementary tool is provided by INFORM (INdex FOr Risk Management), a global, open-source risk assessment for humanitarian crises and disasters. It can be used to support decisions about prevention, preparedness and response. Of particular note are the data and calculation steps showing:

- Risk of humanitarian crises and disasters;
- 5 year trends in risk;
- Where has risk increased most; and
- Prioritization using risk level and trends.

Paris Agreement on Climate Change

The Paris Agreement on Climate Change ([12]) was held in December 2015, at the Paris Climate Conference (CoP21) by 195 countries. It highlighted that Mitigating Green House Gas (GHG) emissions and air pollution can reduce health impacts and costs.

4.4. Health in the Smart City

Growth in the proportion of urban residents making up the global population can impact environmental sustainability, public services, economic growth and social resilience. Effective integration of human, physical, and digital systems would enable cities to be more prosperous, sustainable and resilient ([13]).

The World Health Organization (WHO) Healthy Cities project brings together hundreds of cities under its network to make health a priority on economic, social and political agendas. Boulus ([14]) discussed the importance of Internet of Things (IoT) and geospatial analytics empowering healthy city decisions. One example is the wireless sensors connected to garbage bins to monitor trash levels in Barcelona. This not only provides data for optimization of data collection but can help minimize pollution related illnesses. Overflowing waste containers can cause bacteria to grow, pollute air and water sources, and cause respiratory diseases, salmonella, and fever among others.

Mobile Health in an information technology field that advances the use of mobile devices to support health services and information. Information from mobile health and smart cities can improve healthcare and overall quality of life ([15]).

4.5. Scenarios

please add your scenario here

Chapter 5. Data Considerations and Related Recommendations

5.1. Conceptual model recommendations

The INSPIRE report A Conceptual Model for Developing Interoperability Specifications in Spatial Data Infrastructures P. 40, 46, 52 provides [16] important mode recommendations for services data and data harmonization:

- **Download Service Strategies** - To make data available through a download service, data is typically transformed offline to create a static view that is compliant with the interoperability target specification and respecting privacy laws. Alternatively, data can be transformed inside the download service ‘on-the-fly’, according to previously defined mapping rules. A third option is to use a separate transformation service that executes predefined or user-defined mapping. It should be the responsibility of each data provider to choose the method and enable the necessary data transformation according to this choice.
- **Harmonized Schema and Use Cases** - Pursuing the principle that the SDI should bring together existing data, requirements from use case scenarios should be compared with existing ‘as-is’ data availability. This analysis can reveal whether the requested data can be supplied by the data providers. If so, it also shows the complexity of the related transformation work. If there is no one-to-one relationship between the proposed harmonized schema and the theme-related datasets, data integration might be still required at the level of the data sources or by the users. An example of a harmonized model is the INSPIRE UML class for health statistical data model.
- **Controlled Vocabularies** - Health data systems should put efforts on using a common controlled vocabularies. Control vocabularies might be required for treatment names and codes, environmental conditions, etc. Exiting controlled vocabularies are:
    - UMLS
    - SNOMED-CT
    - MeSH

5.2. Functional areas recommendations

Building a framework requires to partition the data needs in functional requirements. The suggested functional areas are as follows:

- data collection
- data access

- data processing
- data publication and sharing
- data visualization and decision support
- data privacy and protection
- data discovery
- semantic rich metadata
- data from sensors

5.3. Data recommendations

- **Data Security** - Data stored in the cloud needs to be highly secure (critical applications) and comply with legal constraints
- **Data Anonymization** - Aggregated data needs to be anonymized at an appropriate level, considering national regulations on aggregation of health data at given scales. ISO provides SDMX-HD ISO 17369:2013: non-personalized, statistical, health data schema (D4.14 WHO)-add reference
  - **De-Identification** - In the context of U.S. Federal health care regulation, the Health Insurance Portability and Accountability Act (HIPAA) provides guidance on methods for de-identification of protected health information (PHI). Protection is also afforded to patients receiving treatment for substance abuse disorders.

5.4. Data Requirements

The following table provides information about the data, its type and application area.

Needs completion and discussion with the working group

Name	Description	Type	Area	Standards
Population and Socio-Economic Statistics		Vector	climate health, global indicators	CSV, WFS, GML
Discharge Data and Health Outcomes		Vector		
Weather		Coverage		
Social Vulnerability Indices		Vector		
Climate Data	Predictive Models		Coverage	

Name	Description	Type	Area	Standards
WCS	Disaster Loss Data		Vector	
	Remotely Sensed Data		Coverage	
	Sensor Data		Sensor	

For the data requirements the following types of data are assumed:

- **Vector**: Data that can be represented as point lines or polygons. Tabular data can be represented in vector format if there is a column that provides the geospatial coordinates.
- **Coverage**: Usually gridded data including raster and model outputs that has a grid as a reference.
- **Sensor**: Data is more dynamic in nature than vector and coverages, usually a time series of a sensor in particular location

Formats and Standards include:

OASIS EDXL HAVE

OASIS EDXL HAVE

HL7 SDMX-HD

HL7 SDMX-HD

CSW

The OGC Catalog Services for the Web provides a web interface to discover, get and update geospatial resources, including data and services.

CSV

Encoding to represent data in a tabular format, separated by a comma.

GeoJSON

Encoding for vector data written in JSON.

GeoSPARQL

OGC standard for representing and querying geospatial data on the Semantic Web. It extends SPARQL to allow querying of geospatial data and provides the language to represent geospatial data in RDF.

GML

The OGC Geography Markup Language, based on XML, is used to represent and share geospatial features. It also provides the means to define conceptual models (i.e. features types).

GTFS

Encoding for sharing transit data. It is composed of a set of CSV files grouped together under a zip file.

ISO 19115 and 19139

Geographic information — Metadata Model and XML Schema

ISO 19117

Geographic information — Portrayal. Specifies a conceptual schema for describing symbols, portrayal functions that map geospatial features to symbols, and the collection of symbols and portrayal functions into portrayal catalogs.

KML

OGC standard, formally known as Key Hole Markup Language, is an XML language for expressing geographic annotation and visualization for two-dimensional and three-dimensional representations of the Earth.

O&M

The OGC Observations and Measurements defines a conceptual schema for encoding observations. Shapefile::Esri vector data format for storing information about geographic features.

OSM

Open Street Map data format encoded in XML. The model is composed of nodes, ways, and relations. Usually, the file ends with .osm. If compressed then the file will end with .bz2 or .pbf.

OWL

The W3C Web Ontology Language, is the de facto language to encode ontologies or rich conceptual models. It is built on the RDF model.

RDF/SKOS

The W3C Resource Description Framework provides a language to encode ontologies (rich conceptual models) or simple controlled vocabularies (e.g. multilingual gazetteers.)

SLD

The OGC Styled Layer Descriptor is a standard that enables an application to configure in an XML document how to properly portray layers and legends in a WMS. It uses

Symbology Ending (SE) to specify styling of features and coverages.

SOS

The OGC Sensor Observation Service provides a web interface to query sensors systems and data from sensors.

SPARQL

W3C recommended language to query RDF resources.

WCS

The OGC Web Coverage Service provides a web interface for querying coverages (i.e. digital geospatial information that varies in space and time).

WFS

The OGC Web Feature Service provides a web interface for querying and updating geographical features (i.e. vector data).

WMS

The OGC Web Map Service Interface Standard provides a web interface for requesting map images over the web.

WPS

The OGC Web Processing Service provides a web interface to run processes (e.g. classification, buffer, clipping, and geocoding).

Chapter 6. Architecture Framework

Needs discussion - Combine Eo2Heaven, image from Eddie in a 3tier architecture.

Appendix A: Revision History

Date	Editor	Release	Primary clauses modified	Descriptions
April, 2017	Eddie Oldfield	.1	all	initial version
May 12 2017	Luis Bermudez	.2	all	formatted in Asciidoc, overall edits and restructuring
June 7, 2017	Scott Serich	.3.0	all	Performed overall general checking to prepare for issue resolutions
June 8, 2017	Scott Serich	.3.1	all	Resolve GitHub Issue #1
June 8, 2017	Scott Serich	.3.2	all	Resolve GitHub Issue #2
June 8, 2017	Scott Serich	.3.3	all	Resolve GitHub Issue #3
June 9, 2017	Scott Serich	.3.4	all	Resolve GitHub Issue #4
June 9, 2017	Scott Serich	.3.5	all	Resolve GitHub Issue #5
June 9, 2017	Scott Serich	.3.6	all	Resolve GitHub Issue #6
June 9, 2017	Scott Serich	.3.7	all	Resolve GitHub Issue #7
June 9, 2017	Scott Serich	.3.8	all	Resolve GitHub Issue #8
June 9, 2017	Scott Serich	.3.9	all	Resolve GitHub Issue #9
June 9, 2017	Scott Serich	.3.10	all	Resolve GitHub Issue #10

Date	Editor	Release	Primary clauses modified	Descriptions
June 9, 2017	Scott Serich	.3.11	all	Resolve GitHub Issue #11

Table 2. Revision History

Appendix B: Bibliography

1. L. Friedl, Group on Earth Observations, Report GEO Task US-09-01a, 2010.
2. J. Lorenzo and K. Watson, "Earth Observation and ENVironmental modelling for the mitigation of HEAlth risks - D1.8 Final Report," EO2HEAVEN Consortium, Report, 2013.
3. INSPIRE, "D2.8.III.5 Data Specification on Human Health and Safety – Technical Guidelines," INSPIRE Thematic Working Group Human Health and Safety, Report D2.8.III.5_v3.0, 2013.
4. CODATA, "Gap Analysis on Open Data Interconnectivity for Global Disaster Risk Research," CODATA Task Group Linked Open Data for Global Disaster Risk Research (LODGD) , Report, 2016.
5. M. N. K. Boulos, "Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom," *International Journal of Health Geographics*, vol. 3, no. 1, 2004.
6. T. W. Tam, "Preparing for influenza epidemics and pandemics in the new millennium," *Can J Public Health*, 1999.
7. N. Watts, W. N. Adger, S. Ayeb-Karlsson, Y. Bai, P. Byass, D. Campbell-Lendrum, T. Colbourn, P. Cox, M. Davies, M. Depledge, A. Depoux, P. Dominguez-Salas, P. Drummond, P. Ekins, A. Flahault, D. Grace, H. Graham, A. Haines, I. Hamilton, A. Johnson, I. Kelman, S. Kovats, L. Liang, M. Lott, R. Lowe, Y. Luo, G. Mace, M. Maslin, K. Morrissey, K. Murray, T. Neville, M. Nilsson, T. Oreszczyn, C. Parthemore, D. Pencheon, E. Robinson, S. Schütte, J. Shumake-Guillemot, P. Vineis, P. Wilkinson, N. Wheeler, B. Xu, J. Yang, Y. Yin, C. Yu, P. Gong, H. Montgomery, and A. Costello, "The Lancet Countdown: tracking progress on health and climate change," *The Lancet*, vol. 389, no. 10074, pp. 1151–1164, 2016.
8. U.N., "Report of the Inter-agency and Expert Group on Sustainable Development Goal Indicators," United Nations Economic and Social Council, Report E/CN.3/2017/2, 2016.
9. U.N., "Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction," United Nations General Assembly, Report A/RES/71/276, 2016.
10. U.N., "Sendai Framework for Disaster Risk Reduction 2015 - 2030," United Nations, Report, 2015.
11. R. Maini, L. Clarke, K. Blanchard, and V. Murray, "The Sendai Framework for Disaster Risk Reduction and Its Indicators—Where Does Health Fit in?," *International Journal of Disaster Risk Science*, no. doi:10.1007/s13753-017-0120-2, pp. 1–6, 2017.

12. U.N., “Paris Agreement,” United Nations, Report, 2015.

13. G. Percivall, “OGC Smart Cities Spatial Information Framework,” Report, 2015.

14. M. N. K. Boulos and N. M. Al-Shorbaji, “On the Internet of Things, smart cities and the WHO Healthy Cities,” *International journal of health geographics*, vol. 13, no. 1, 2014.

15. A. Solanas, C. Patsakis, M. Conti, I. S. Vlachos, V. Ramos, F. Falcone, O. Postolache, P. A. Pérez-Martínez, R. Di Pietro, and D. N. Perrea, “Smart health: a context-aware health paradigm within smart cities,” *IEEE Communications Magazine*, vol. 52, no. 8, pp. 74–81, 2014.

16. K. Tóth, C. Portele, A. Illert, M. Lutz, and M. N. de Lima, “A conceptual model for developing interoperability specifications in spatial data infrastructures,” Office for Official Publications of the European Commission, Report Report EUR 25280 EN, 2012.