



Health Summit Report

Dublin, Ireland - June 21, 2016

Introduction

This report is a summary of the OGC Health Summit which took place during the OGC TC, on June 21, in Dublin, Ireland. The highlights and recommendations this report contains are useful to inform the OGC Health Domain Working Group (OGC Health DWG) and more broadly speaking, the global health community, on requirements for advancing open geospatial (OGC) standards.

Background

Advanced countries strive to provide economical health care to an increasingly ageing population; and people want to stay active and healthy in their own homes as long as possible. On the other hand, people in the developing world still suffer from diseases, some neglected by the developed world, exacerbated by lack of access to safe water and sanitation or medical treatment.

Climate and environmental factors have a huge health impact across the world: air and water quality, heat waves, floods and droughts are just a few prominent examples. These factors impact humans not only directly, but also indirectly through the vectors (insects, animals) transporting bacteria and viruses. In addition, increasing urbanization poses new challenges at the junction of health, environment and the economy. The complex relationships between health and the environment need to be better understood and integrated into policy and decision making systems for both health authorities and individuals.

Health and wellbeing are closely tied with location. Location information is helpful to address health issues. Several agencies need standards for interoperable geospatial data exchange, processing and visualization to address health issues. OGC aims to identify and foster the development of supporting geo-spatial standards. The OGC Health DWG organized the Summit to bring attention to health market requirements, technical solutions, advances in geospatial standards, and implementation/application examples.

Summit Goals

The OGC Health Summit (Dublin, June 21) served to:

1. Convene OGC Health DWG participants, OGC members, other interested stakeholders:
 - a. 45 participants convened
 - b. Held 4 panels, 4 interview rounds, and a technology showcase with multiple exhibitors
2. Inform how geospatial standards and related technologies can benefit the health domain
 - a. identified key areas of need in the market
 - b. identified beneficiaries, stakeholders, key gaps / application areas, resources
3. Identify requirements for OGC standards, and Interoperability work
 - a. identified geospatial data and web service requirements (interoperability standards)
 - b. identified actions to flow from the Summit

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Highlights from the Summit:

Registered participants included OGC members and non-members: Government, Academia, Technology providers, national and international organizations: e.g. GEO, WHO, NOAA, Public Health England, UNCAP, etc. (see Registered Participants: https://portal.opengeospatial.org/public_ogc/register/160621health_view.php)

Welcome remarks and an Opening Presentation provided by Dr. Kym Watson, Fraunhofer IOSB, Co-Chair, OGC Health DWG. The presentation included background of the OGC Health DWG, state of activities, and examples of application areas of interest. It also outlined the goals of the OGC Health Summit and schedule.

Across all health application areas, interoperability is seen as the greatest challenge and need. OGC Standards are considered critical for ensuring interoperable technical solutions for geospatial data exchange, integration, analysis, visualization, etc. Addressing global challenges, such as the impacts of climate change on human health, require interoperability between diverse systems and data. National ownership can be key toward data access, support, and policy. It was noted that there are many different stakeholders: individuals and organizations at local, national, and international levels, each with different requirements of data and privacy.

See Appendix 1 for List of Presentations. You can click each Title to download a PDF.

Panels

Panel 1 – Active and Healthy Ageing

The panel included three presentations pertaining to use of OGC standards for applications addressing needs of ageing population. The presentations in this panel were given by representatives of the EU H2020 project UNCAP (Ubiquitous iNteroperable Care for Ageing People; <http://www.uncap.eu/>):

Prof. Panagiotis D. Bamidis, Assoc. Prof. of Medical Education Informatics, Lab of Medical Physics, Medical School of the Aristotle University of Thessaloniki (AUTH) - UNCAP - Taking Active and Healthy Ageing out of the box: from ecological invalidity to 'wild' ageing trials

The presentation explained the benefits of serious interactive exergames for the elderly to preserve or improve their cognitive abilities. An exergame ontology has been developed as a contribution to IoT semantics. Prof. Bamidis gave an overview of his Active and Healthy Ageing Living Lab at the Aristotle University of Thessaloniki. He recommended the development of a) interoperable exergame services and b) device and application standards for Living Labs.

Giuseppe Conti, Trilogis - The experience of the UNCAP project on active and healthy ageing funded by the European Commission

Giuseppe Conti gave an overview of the UNCAP project of which he is the coordinator. The UNCAP focuses on helping the elderly in their daily activities and in coping with cognitive impairments. The user groups for the UNCAP results include not only the elderly, but also carers and medical practitioners. On the technological side, UNCAP integrates a wide range of sensors and smart devices and applications for health monitoring, including biometric sensors and floor sensors to detect movements and falls. Standards of KNX (fieldbus in building automation), HL7, OGC and ETSI and interRAI (health assessment) are used. The UNCAP implementation architecture has three tiers: sensors in the lowest tier with proprietary interfaces, in the middle tier the UNCAP box providing a semantic and syntactical conversion of data to standard formats, in the upper tier cloud based services for third parties and public health agencies.

Wolfgang Kniejski, INI-Novation GmbH - UNCAP Access to Market – Business and Service Delivery Models

The main concerns in the health domain are identifying new business and service delivery models, establishing procurement models that can accommodate the future care market, defining licensing models and Service Level Agreements, dealing with IPR and standardization for sustainable solutions. This requires a good understanding of the value generation chains.

After the panel presentations, participants had an opportunity to ask questions and the group discussed items of interest. *Some key messages from panel 1:*

- Key challenge: Sensor devices need *certification* (CE); services need *accreditation* from local health fund / authorities to attract financial support; Procedures for data collection need *ethical approvals*
- Data stored in cloud: needs to be highly secure (critical applications) and comply with legal constraints
- Need for services (e.g. OGC Standard-based web map services) for exercise gamification, assisted living, and Living Labs
- AHA O&M profile should be advanced (proposed new Standard Working Group /SWG)
- UNCAP – lessons learned can inform OGC Health DWG
- Need for case studies or best practices for implementation of OGC standards/technical solutions

Panel 2 – IoT, Healthy Urban Environments

The panel included four presentations on aspects of health related to the urban context. Panelists shared viewpoints on the potential for sensor web and IoT to address health needs. They identified specific application areas and gaps in geospatial data and interoperability, shared the need for best practices / standards for collecting data and mapping health information and/or for correlation with environmental data at various scales and time periods, from diverse/distributed sources.

Sara Saeedi and Steve Liang, University of Calgary, SWE DWG - IOT SWG – Opportunities and Challenges of OGC SensorThings API and Wearables.

There is an increasing variety of compact sensors with a communications interface for health monitoring. The market for wearable health tracking sensors is expanding and now includes electronic skin patches. The OGC SensorThingsAPI is an open specification to interconnect IoT devices such as health sensors, data and applications over the web, e.g. by putting sensor data in a cloud with a standardized interface. The specification is providing the basis for a rapidly growing product spectrum (esp. low cost hardware and easy to use software).

Fabio Roncato, Trilogis - The importance of interoperability for the UNCAP framework, AHA O&M Profile

Achieving interoperability between health care information systems and sharing of device data could yield huge benefits not only in financial terms, but also in reducing the number of medical errors. UNCAP has developed a profile of the OGC O&M for active and healthy aging as a basis to improve the interoperability of health devices and applications. The profile includes topics from both technical and medical viewpoints as identified in the UNCAP use cases with a focus on aspects relevant to elderly care. The health related terminology draws upon MeSH (Medical Subject Headings), SNOMED (Systematized Nomenclature of Medicine) and UMLS (Unified Medical Language System).

It was recommended that a draft Charter be developed toward forming a new AHA O&M SWG, to further advance the O&M profile / development of new standard.

Prof. Liping Di, Professor and Director, Center for Spatial Information Science and Systems, George Mason University - Does urbanization play a big role in the rapid increase of Lyme disease cases

The presentation showed the spatial patterns of Lyme disease in USA and relationship to socio-economic factors. There is a clustered high-risk of Lyme disease in areas with the dense population, rapid urbanization, higher income and lower distance to metropolitan areas. Recommendations for OGC standardization: a) Define land use/cover classification schema suitable for public health applications, b) How to provide more spatial/temporal details on Lyme disease while preserving patient privacy.

Kym Watson, Fraunhofer IOSB - Summary of report: The Junction of Health, Environment and the Bioeconomy.

The presentation summarized the main results and recommendations of an EC expert group on foresight and implications for European Research & Innovation policies at the junction of health, environment and the bioeconomy with regards; cf. report under <http://ec.europa.eu/research/foresight/>.

There are four emerging important themes, all requiring a systemic approach going beyond the three fields health, environment and bioeconomy by encompassing issues of energy and mobility: 1) Sustainable food, 2) Circular, bio and blue economy, 3) Cities, 4) Holistic health. Many interwoven factors impact health in cities; more than 67% of Europeans and by 2050 more than 70% of the world's population now live / will live in cities. Decision makers need better data and understanding of issues, to target actions such as city planning efficiently and cost effectively. The expert group recommended to explore the exposome concept (i.e. the totality of environmental exposures) to integrate health, environmental and demographic determinants.

After the panel presentations, participants had an opportunity to ask questions and the group discussed items of interest.

Key Messages from the panel session include:

- IoT / SensorThings API lends particularly well to health – for both health and environmental sensor data integration; at lower cost. Connecting sensors (indoor, outdoor) in network adds value. IoT is evolving rapidly. Standards can ensure interoperability of IoT with geospatial/health applications.
- O&M profile(s) can standardize data collection, reduce cost, reduce time spent on data collection and processing. It was recommended that a Charter be developed for an AHA O&M SWG, to advance a new standard / documentation.
- Need for scalable health information / access (or well defined protocols for using health information in mapping applications while protecting privacy), to better understand interaction between disease (e.g. vector borne) and health determinants (including environment, built environment, lifestyle, demographics, etc)
- Need land use classification schema useful for health applications.
- Some interest in forming a SpectrumML DWG, to develop an open standard electromagnetic field EMF data model and derived encodings
- A Challenge / Need best practices: to measure the exposome (totality of environmental exposures)
- Take a holistic approach to understanding health / risks

Panel 3 – Climate Health

This panel included five presentations pertaining to the nexus of climate change and health, addressing key challenges with interoperable geospatial data and web service (OGC) standards.

Professor Virginia Murray, Public Health England; Vice-chair of UNISDR Scientific and Technical Advisory Group; Member of UN Sustainable Development Solutions Data Network; Co-Chair IRDR Disaster Data Loss Project (DATA) project

Geospatial standards are important to the **2015 UN Landmark Agreements** – for example:

- (1) The [Sendai Framework for Disaster Risk Reduction 2015–2030](#) aims to reduce disaster losses in lives, livelihoods, and health, adopted in March 2015 in Sendai, Japan by 187 United Nations (UN) member states;
- (2) The Sustainable Development Goals (SDGs)—successors of the Millennium Development Goals—agreed in September 2015 in New York, USA by 193 countries; and
- (3) The Paris Agreement on Climate Change, agreed on in December 2015 at the Paris Climate Conference (CoP21) by 195 countries.

Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data. It was noted that OGC standards could be particularly relevant to facilitating geospatial data exchange, integration, visualization for disaster risk reduction, including to reduce health impacts of climate change. The Sendai Framework, amongst other calls for data, emphasizes the need '*[t]o promote real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data*'

The UN ISDR Science and Technology Conference – Mobilising science to implement the Sendai Framework – was held January 2016, in Geneva, Switzerland. One of the key messages from the conference included '*Support open access, multi-hazard data platforms and standardized approaches and tools to map and use of data and scenarios that make science sensible to decision makers and the general public. Strengthen DRR science-policy and cross-sectoral dialogues to facilitate risk assessments, post disaster reviews, data sharing, and decision making*'.

Here are some additional links:

- The [UN Sustainable Development Solutions Network for Data Integrated Research on Disaster Risk](#); The [IRDR's Disaster Loss Data \(DATA\) project](#);

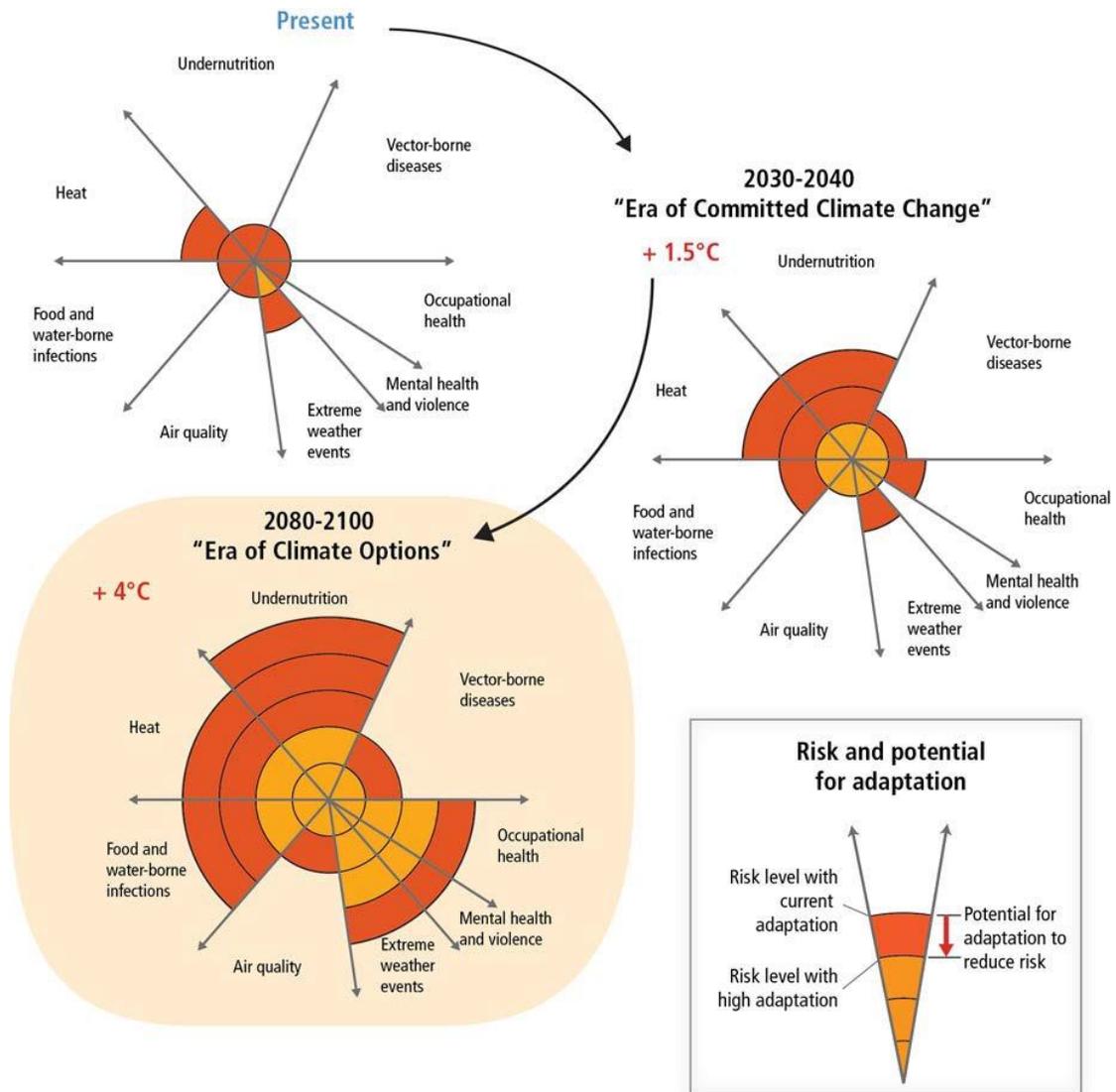
Dr. Joy Shumake-Guillemot, WMO/WHO Climate and Health Office - Climate Services for Health

Impact Pathway of Climate and Weather on Health Outcomes, can be understood at a high level as interactions between:

- **Risk Factors** - e.g. Weather/Climate, Disease Vectors, etc;
- **Vulnerability**
- **Impacts** - e.g. injury, illness, death.

Some of these impact pathways are expected to change with climate change.

Figure 1: Current and Future Climate Related Health Risks



Source : Alistair Woodward et al Lancet 2014

However, climate and weather science and information is generally inaccessible and unusable to health professionals. Processes and tools are needed to:

- determine the relevance and needs for climate information,
- improve access
- translate, interpret, transform, and blend information
- discuss and understand uncertainty of probabilistic forecasting
- take informed action

Climate services are a new type of health service that can improve the effectiveness of our core business –detecting disease, monitoring health risks, anticipating problems, and taking action to save lives.

Margaret Chan, WHO Director General
Statement to the Intergovernmental Board on Climate Services, Nov. 2014

Climate services are mission-oriented partnerships driven by societal needs, which result in the production and delivery of relevant, authoritative, timely and usable information about climate change, climate variability, trends, and impacts to improve decision-making in climate sensitive sectors. For case studies see:

<http://public.wmo.int/en/resources/library/climate-services-health-case-studies>

Lessons learned - Climate health services need to consider:

1. research to identify climate signal between exposure and health impact
 2. timescale of impacts and decisions
 3. geographic scale of risks and decisions
 4. availability, quality, usability, and relevance of information to match the above needs
- *Other considerations include cost-efficacy and available resources.

Recommendations:

- Standards and methods which facilitate the translation, visualization, interoperability, and use of spatial data are needed.
- Interoperable spatial-based platforms which are nationally owned are the key for the health sector to unlock potential applications of climate and environmental risk information
- Digital decision-tools and data visualization are highly sought
- Training in spatial statistics and spatial epidemiology critical skill set

Dr. Joy Shumake-Guillemot leads the WHO/WMO joint office for Climate and Health in Geneva Switzerland. Her current work focuses on supporting WMO and WHO to accelerate the availability, access and use of climate and weather information for public health policy and practice. Joy was the lead author of the WHO Operational Framework for Climate Resilient Health Systems, the health strategy for the Global Framework for Climate Services, the WHO/WMO Climate Services and Health global case studies project.

Douglas Cripe, GEO Secretariat – GEOSS – report on applications in the health and environment area

Earth Observations are needed to inform decisions. GEO's Vision is to realize a future wherein decisions and actions, for the benefit of humankind, are informed by coordinated, comprehensive and sustained Earth observations and information. GEO Objectives include to Improve and Coordinate Observation Systems; Advance Broad Open Data Policies/Practices; Foster Increased Use of EO Data and Information; and Build Capacity.

A key initiative of GEO is Global Earth Observation System of Systems (GEOSS). GEOSS provides coordinated access to information from various sources, including through an online portal. GEOSS Implementation is based on Data Sharing Principles: Full and Open Exchange of Data, Data and Products at Minimum Time Delay and at Minimum Cost, Free of Charge or Cost of Reproduction.

One of the societal benefit areas under GEO, is Public Health Surveillance. Public Health Surveillance SBA is interested in how to use Earth observations for:

- yielding insight into the threat of vector-borne and environmentally-linked diseases, taking into account impacts of climate change.
- promoting a substantial reduction in the number of fatalities and illnesses from infectious diseases, environmental pollution and health risks.
- raising public awareness, and supporting policy making and management with accurate monitoring and early warning at local, national, regional and global levels.
- supporting monitoring frameworks of the *Health SDG*.

The 2016 Work Programme includes:

- GI-04: Global Observing System for Mercury and Persistent Organic Pollutants (PoPs)
- GI-12: Integrated Information Systems for Health (Cholera, Heat waves)
- GI-13: Integration of Methods for Air Quality and Health Data, Remote Sensed and In-Situ with Disease Estimate Techniques

Tools needed for Health Decision Making:

- Globally integrated Cholera Early Warning System
- Online map-rooms for Malaria & Meningitis prevention
- Secretariat support needed
- Links with UN Sustainable Development Goals (SDGs)

Some key challenges are:

- Technicalities
- Users (and user requirements)
- Observing systems
- Data sharing

“Technology is a valuable tool that has the potential to transform the way we work, can deliver cost efficiencies, increase transparency, and make the work of an organization more relevant to what is happening around the world in real time. When used effectively, technology can accelerate progress toward development goals in health, food security, climate change, energy and environmental sustainability”.

Relevant link: <http://www.earthobservations.org>

Juli M. Trtanj, One Health Lead, Climate and Weather Extremes Integration Lead, NOAA Climate Program Office - Climate and Health: Overview from the United States - NOAA, the US Climate Health Assessment, the National Integrated Heat Health Information System, and International Engagement

This presentation included an overview of US Global Change Research Program Climate Change and Human Health Interagency Crosscutting Group. In addition, it provided a snapshot from “The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment” and follow on actions (health2016/globalchange.gov). The presentation also provided an overview of the NOAA One Health Group; The National Integrated Heat Health Information System (NIHHIS) and Global Heat-Health Information Network; and International Activities.

It was noted that climate change affects human health in two main ways. It can change the severity or frequency of health problems that are already affected by climate or weather factor. It can also create unprecedented or unanticipated health problems or health threats in places where they have not previously occurred. More specific climate change impacts were presented, as well as specific actions by NOAA – e.g. NOAA One Health Group will advance NOAA’s science and services to inform health decisions through: improved understanding of the linkages between environmental conditions and health outcomes, and delivery of useful prediction products, data and tools.

What is needed are predictive models at the right scale and level of certainty, stronger research collaborations on targeted applications, and improved integration of public health and environmental data. In general, it was noted that longer term sustained engagement is needed to advance geospatial interoperability standards / solutions, it was suggested to strengthen existing networks and research funding, identify data needs in specific applications/projects, and conduct test beds.

Elysa Jones, Chair OASIS, Emergency Management Technical Committee, Emergency Interoperability Member Section - OASIS Emergency Data Exchange Language (EDXL), Standardized Data Sharing in Support of Healthcare Preparedness and Response.

EDXL Published by the Organization for the Advancement of Structured Information Standards (OASIS) The presentation provided an overview of EDXL Standards, relevant to data exchange for health applications, including:

- The EDXL-Hospital Availability Exchange (HAVE) Standard
- The EDXL-Tracking of Emergency Patients (TEP) Standard
- Bi-directional Transformation of OASIS EDXL-TEP (Tracking of Emergency Patients) v1.1 and HL7 v2.7.1 Specification Version 1.0

The Standards are based on open, voluntary, collaborative process by First Responder, Emergency and Disaster Management, and Industry experts; The Standards are available internationally (free).

After the panel presentations, participants had an opportunity to ask questions and the group discussed items of interest.

Key messages from the panel include:

- It was noted that Data collection is needed at all levels of government / is a shared responsibility. Participants indicated a need for standard methods for aggregation, disaggregation, anonymization, i.e. Best Practice documents. Some participants indicated a need for Open Access multi-hazard data platforms (using OGC standards).
- In respect to climate change, it was noted that locally appropriate action requires local information / evidence, although these are global issues. It was also noted it is a challenge to geo-enable Impact pathways (direct vs indirect) to inform the health community. Climate Change data/science not easily understood in health community. This challenge that can be met with interoperable geospatial data and services to analyze impact pathways along the chain from environment factors to a health outcome.
- Participants shared the view that OGC Health DWG should strengthen linkages with: other SDOs e.g. OASIS Emergency Management Technical Committee; as well as GEO (in particular the GEO Health and Environment Community of Practice), UN ISDR / Sendai framework, IRDR, EM / DRR community, SDGs, with OGC Health DWG. Collaborative activities could help advance OGC standards to support climate-health applications.

Panel 4 –Standards in Action

The panel included three presentations pertaining to OGC standards, and interoperability among standards.

Scott Cadzow, C3L, UNCAP – EU Standards in eHEALTH covering privacy, security and ethics

A good foundation for eHealth: Effective, timely, correct, health monitoring and medical intervention that is ethical, fair, equitable and treats both the patient and the care system actors with “dignity”. In line with this, it is important to protect privacy when implementing health monitoring solutions – for this Standards are critical. Geo-eHealth tags medical events with geo location data – useful to identify where events occurred, assist in understanding source of outbreaks and monitoring disease spread, mitigating outbreaks / health risks, track and manage medical equipment, and to support patient care. Ethics and privacy concerns need to be addressed in the design of solutions (privacy-by-design).

The health market is worth many billions of \$/£/€ annually. However, standards in eHealth are underfunded. No standards will lead to fragmentation – i.e. lots of little proprietary markets (even if little could be 100s of millions of \$/£/€). There is a need to invest in standards – for better health care, and so that solutions providers find a bigger market. There is also a need for multiple standard organizations to work collaboratively (e.g. ETSI, ISO, HL7). In Europe, it's an objective of the H2020 programme to enable open access – that means open code (open reference implementation) and open standards (open reference design and requirements). EU standards are developed across the trinity of CEN/CENELEC/ETSI. ETSI Work Item DTR/eHEALTH-007 “Standardisation use cases for eHealth” is ongoing. For geo-eHealth OGC feeds into CEN TC287.

Denise McKenzie, OGC – Update on work of the UNGGIM Expert Group

The presentation included an overview/background of the UNGGIM Expert Group. The United Nations initiative on Global Geospatial Information Management (UN-GGIM) aims at playing a leading role in setting the agenda for the development of global geospatial information and to promote its use to address key global challenges. It provides a forum to liaise and coordinate among Member States, and between Member States and international organizations. The UN-GGIM Committee is a Committee of experts in the United Nations Statistics Division, with an expert group on integration of statistical and geospatial information. From the report of their 5th Meeting, they “Emphasised again that statistical and geospatial communities are major contributors of information used for evidence-based decision making across many sectors, whether public or private at national and global levels. In this context, the Committee highlighted the opportunity with implementation of the 2030 development agenda and the ongoing debate in disaster risk reduction, and stressed that increased institutional coordination and cooperation between the geospatial and statistical agencies, as well as other stakeholders, is vitally important and a key factor to the success of data integration.”

There is also the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs). Building on the strong cooperation between the Standards Development Organisations, ISO, IHO and OGC will convene a JSG to review the SDGs and indicators. The JSG will:

- Identify relevant existing supporting geospatial standards and identify gaps in the existing geospatial standards architecture that may need to be developed
- Invite the relevant ISO statistics committees in particular with ISO/TC69 – Statistical Methodologies and ISO/TC 154 - Processes, data elements and documents in commerce, industry and administration (SDMX standard)
- Invite members and observers of the UNGGIM to participate in the JSG in particular from the Expert Group on the Integration of Statistical and Geospatial Information

It was noted that any OGC member can request observer status to UN-GGIM.

It was also noted there is a proposal for a global statistical geospatial framework, based on:

- Statistical Spatial Framework (Australia)
- Generic Statistical Business Process Model (GSBPM)
- INEGI (Mexico) national institution model

Pertinent link : <http://ggim.un.org/docs/meetings/3rd%20UN-EG-ISGI/Proposal-for-a-global-statistical-geospatial-framework.pdf>

John Herring, Oracle, Urban Planning DWG – Smart Cities and Health

A Smart City should be described as one that dramatically increases the pace at which it improves its sustainability and resilience, by fundamentally improving:

- how it engages society,
- how it applies collaborative leadership methods,
- how it works across DISCIPLINES and CITY SYSTEMS, and

- how it uses data and integrated technologies, in order to transform services and quality of life to those in and involved with the city (residents, businesses, visitors).

There are many relevant standards to take stock of. This will include for health application areas, as well as urbanization, infrastructure, energy, governance, and more. Many of these are already OGC domain areas, and/or have relevant ISO TC 211 Standards. OGC Members have developed a draft SmartCities DWG Charter – in which health and environment are identified as potential application areas of a Smart City. It will be important to cross-pollinate with the Health DWG.

After the panel presentations, participants had an opportunity to ask questions and the group discussed items of interest.

Key Messages from the panel:

- A key highlight from this panel was the need for security in eHealth, especially for systems that support medical uses.
- Participants also recommended informing other OGC SWGs of requirements coming from health related use cases (e.g. WPS, SPS, UP/Smart City).
- It was noted that OGC members can be observers to the UNGGIM.
- It was also noted that liaison efforts (between OGC and other standards organizations; or with other organizations) will help advance geospatial standards to support health applications.

Matrix Results

The Interview Matrix is a way to gather input from all participants in short time (20 minutes). It consists of four questions – participants were assigned a question (#1-4), then grouped into four, and within each group each person had the opportunity to ask each other person their question, record their answers and then add their own answer. Each interview round was 2 minutes. Responses collected and compiled, for the following questions, include:

Matrix Question 1 – Identify 1 or 2 health application areas/scenarios.

Any Key Issues / Needs.

Many needs and corresponding issues were identified, with some common to all participants. Many participants shared the need to standardize geospatial data exchange, integration and visualization (e.g. web service encodings, data service and web service profiles / best practices) including for health and non-health data used in public health applications. This includes data already organized according to health data standards e.g. HL7, (-FHIRE); and non-health data standards.

Public health authorities and health care providers find value in using location information with health information. **Application areas** (existing and new) identified include:

- **Taking knowledge from data** –to understand what parameters affects diseases. Augment Population Health Informatics, Population health management, Patient experience / patient tracking, resource planning / allocation, Monitoring health indicators (heart rate). Time-series over long period, in order to mine data. Having sensors monitoring constantly to recognize symptoms.
- **Active and Healthy Ageing**, Fall decision / Fall prevention, activity monitoring, to ensure less health problems for the elderly

- **eCare, Mobile Health** – services to increase mobility and care environment; relationship between access to public health services and community health; Next generation first responder – sensors in the field; simplifying triage areas; Social Media could be harnessed to identify patterns to location/interests, could point to health issues.
- **Disease control** (e.g. Lyme), monitoring disease distribution / burden in population (e.g. chronic illnesses like COPD, Asthma, Diabetes, Cancer; vector borne, or infectious diseases), patient data / exposures, causes of disease, and environmental determinants of disease.
- **Monitor risk for vector-borne disease**, including with projected changes in climate. E.g. meningitis and cholera early warning systems;
- **Understand environmental influence:** e.g. links between air pollution, climate change, heat events, water quality, disease transmission and human health. Participants noted there are direct climate impacts on human health, e.g. Correlation w/ heat and heart rate - heat events can exacerbate respiratory and cardiovascular conditions. Extreme weather events can cause direct and indirect impacts, for example direct injury vs breaking down of air conditioning in July or loss of power and heating in the winter. Participants shared interest in local and global atmospheric and environmental pollutant monitoring data.
- **Other:** Treatment. Monitoring. E.g. ECG monitoring. Non invasive, wearable, wireless. Glucose measurement + blood pressure. open EMF data model for bioelectromagnetics.

Needs identified

Some participants noted it is very difficult to integrate data from different platforms; while some expressed interest in a (new) platform for health data input and to mine health indicators (over various time periods at different scales, against different population demographics, land use and environmental variables). Interoperability and data sharing were identified as key challenges and need – e.g. interoperability of different sources of data; interoperability between agencies gathering data; interoperability between geospatial, IoT, and health care technologies - problem is that each device monitors with separate operating systems.

Issues identified

Participants noted a lack of standards for analysis and storage of data, for gathering and conflating data in a way that privacy can be respected, and the lack of a smart system for long term data collection and analysis. Distributed databases also present the challenge/need of having a consistent data model. It's a big data problem. Participants noted a need for faster updates of standards, integration/adoption of location standards in new technologies. Communications between agencies is problematic. Need to raise awareness.

Matrix Question 2 - Are there any gaps (in technology, standards, data)

Participants had a chance to identify any potential gaps in technology, standards or data.

Technology

Some participants felt there were no gaps in technology. Others indicated that interoperability and sharing of data is key to success to any technology introduced into the market. Many shared the view that privacy preservation, Security are key areas for technology to consider/implement. There is a need for wider adoption / help with product development and marketing.

Some participants indicated the cost of sensors can sometimes be prohibitive but there are low cost options. Some participants felt that there was a gap in terms of the interoperability of IoT for environmental monitoring – that could be addressed with OGC standards.

Standards

Similar to the needs identified in Question 1, participants indicated standards are needed for interoperability and exchange of data in a secure way that respects privacy regulations. Some

participants indicated a need for interoperability between standard based web-services and data, in OGC , HL7, OASIS, open mHealth standards, to improve digital health applications. Some participants indicated that gaps exist in standardization, and that the market hasn't widely adopted the standards (not many application examples available).

Data

Participants indicated there is often a lack of spatial details or of scale of public health data. In addition, due to health data sensitivity and due to data collection issues, there is poor data availability. There is a need for standard authentication process for transfers of data (i.e. Permissions) and for OGC standard based web services to operate on distributed data. There is a need to ensure Security and Privacy issues are addressed in the technologies that implement OGC standards. Participants indicated lack of data processing standards (e.g. for solutions on ageing), no standardized geo-statistical methods or techniques to aggregate and normalize health data (spatial/temporal) as well as no standard ways to collect, store, retrieve, integrate, and analyse data. Different diseases require appropriate data models. There are gaps in the exchange of data between different solutions (DB formats - No single standard accepted). Some participants expressed a need for automated systems for data analysis and visualization. It was noted that different languages are spoken between different stakeholders – Ontologies (which are a major stumbling block) could help with Semantic Mediation/Query. Also, the lack of communication technology, access to internet, or of geospatial data in some countries/areas are identified as gaps.

Participants identified several types of data that are useful for health applications, including (but not limited to): food, calories, disease, exercise, measurement and observation; WMO model – list of acceptable terminology; Correlation, Relationship between weather, Climate data for predication with regards to future disease transmission, and for determining health vulnerability/risk and adaptation measures; and Bioelectric magnetic data – collected and shared using a common data model - for epidemiology and exposure reported with a common data model. Health insurance, social media, and other data (e.g. retrieved via API), were also noted.

Matrix Question 3 - For geospatial applications using OGC Standards, who are potential beneficiaries from the application?

The most common response for this is that **key beneficiaries** include the public, patients, elderly and vulnerable populations, as well as Care Providers, Public Health Officials / Government, Organizations, Policy Makers, Nursing Homes (Builders, Staff), Epidemiologists, first responders / public safety. Some participants indicated benefits would accrue to health informatics, to research, and to sensor-based monitoring in real time. Some participants indicated decision-makers would benefit (e.g. issuing alerts, evacuations, first response, disease control, insurance).

Who are key stakeholders?

Participants identified **key stakeholders** as Health care providers (e.g. public and private hospitals, care homes, nurses, private home, family care taker, medical institutions), Government, Centres of Excellence, Technology providers, Data privacy and security agencies (a huge factor in medical IT provision (in the UK)). Participants also identified patients as important stakeholders.

What are factors for success?

Participants identified a key factor is having standards for the collection and exchange of common data, and to ensure geospatial data and technologies are interoperable. Other participants felt that health care / health industry needs to better understand the benefits of using geospatial data, such as to reduce costs and improve health care services. It was felt that the market could open up more (increase acceptance) with improved knowledge sharing, training, communication, improved interoperability, and best practices associated with the implementation of OGC Standards and use of

geospatial data. Some participants indicated that solutions may be driven by private sector, beyond what government and health care providers can do alone.

Matrix Question 4 – What are some of your (or your client’s) key needs / key challenges?

Some key needs/drivers identified (in the market) include to reduce cost, improve patient care, maximize resources, and to have ability to extract knowledge from data to address specific health requirements such as: disease monitoring/studies, fall prevention, alerting, etc.. Other needs include interoperable data and exchange protocols, common vocabulary, making it easier to produce maps, improving education and awareness.

The key challenges include protecting privacy, access to spatio-temporal data at fine scale while protecting privacy, integration of data from different sources and value chains, converting paper based medical records, different levels of health care, and the fact that there is low level of awareness among practitioners in the health community of the benefits of standardization and their impact on health technologies.

Do effective solutions currently exist (technology, web services, data, standards)

Half of the participants said that no effective solutions exist – citing not enough developed services and data, regulations are restrictive, health sector is conservative (risk averse), there is no existing health spatial data infrastructure – only case by case examples and slow market adoption.

Half of the participants said that effective technologies exist, such as networking and mapping services and sensor technologies, however, information access is poor (not easy to collect or publish data), each technology address different facets of health, different areas are more commercially viable due to different regulation and different ethical or privacy frameworks and requirements.

What is a desired future state / goal?

Participants indicated that a future state / goal would include wider accepted interoperable (OGC) standards, along with improved security and privacy regulations, improved policy and processes, seamless and secure data sharing, common vocabulary. Participants also expressed a need for increased implementation of standard-based technologies/services, development of Health Spatial Data Infrastructure, and collaboration between providers and consumers of data. Future applications / areas of interest include to extract knowledge from data, for population health monitoring, disease surveillance, health analytics, crowdsourcing for citizen science, predictive analytics e.g. spread of disease based on current data, decision support, and monitoring health impacts from environmental causes.

Actions Resulting from the Health Summit

Actions identified to at the Summit, included:

- OGC TC Report (PPT), Summary and Webpage with PPT links (Done)
- Blog article (Done)
- Whitepaper (for publication) describing state of geospatial standards in service of health application areas + where work is needed
- Develop charter for AHA O&M SWG (for next OGC TC), + Profile. (Charter developed)
- Establish liaisons with: GEO, UNISDR, WMO-WHO Climate Health Office, IRDR, UN SDGs
- Establish link between GEO Public Health Surveillance SBA, Health and Environment CoP, and OGC Health DWG
- Develop a Document for GEO, UNISDR, WHO – to define role of OGC Health DWG to support their efforts
- Review User Requirements for GEOSS Common Infrastructure (GCI)
- Cross-pollinate with Smart Cities (OGC) initiatives (and other OGC DWGs / SWGs, as needed)
- Review all recommendations from the Summit

This report and the recommendations it contains is shared with the OGC Health Domain Working Group and through the [OGC website](#) and [wiki page](#). Action items will be discussed and addressed by the OGC Health DWG. Progress on these action items will be reported quarterly in 2016/17.

Appendix 1 - Speakers / Presentations

We would like to thank all of our participants, and all of the panel speakers:

Panel 1

- Prof. Panagiotis D. Bamidis, Associate Professor of Medical Education Informatics, Lab of Medical Physics, Medical School of the Aristotle University of Thessaloniki (AUTH) – [UNCAP – Taking Active and Health Ageing out of the Box: from ecological invalidity to ‘wild’ ageing trials](#)
- Giuseppe Conti, Trilogis – [The experience of the UNCAP project on active and health ageing funded by the European Commission](#)
- Wolfgang Kniejski, INI-Innovation GmbH – [UNCAP Access to Market – Business and Service Delivery Models](#)

Panel 2

- Sara Saeedi and Steve Liang, University of Calgary, SWE DWG - IOT SWG – [Opportunities and Challenges of OGC SensorThings API and Wearables.](#)
- Fabio Roncato, Trilogis – [The importance of interoperability for the UNCAP framework, AHA Observation and Measurement Profile](#)
- Prof Liping Di, Professor and Director, Center for Spatial Information Science and Systems, George Mason University – [does urbanization play a big role in the rapid increase of Lyme disease cases](#)
- Kym Watson, Fraunhofer IOSB – [Summary of report: The Junction of Health, Environment, and the Bioeconomy.](#)

Panel 3

- [Professor Virginia Murray, Public Health England](#); Vice-chair of UNISDR Scientific and Technical Advisory Group; Member of UN Sustainable Development Solutions Data Network; Co-Chair IRDR Disaster Data Loss Project (DATA) project
- Dr. Joy Shumake-Guillemot, WMO/WHO Climate and Health Office - [Climate Services for Health](#)
- Douglas Cripe, GEO Secretariat – [GEOSS – report on applications in the health and environment area](#)
- Juli M. Trtanj, One Health Lead, Climate and Weather Extremes Integration Lead, NOAA Climate Program Office - [Climate and Health: Overview from the United States - NOAA, the US Climate Health Assessment, the National Integrated Heat Health Information System, and International Engagement](#)
- [Elysa Jones, Chair](#) OASIS, Emergency Management Technical Committee, Emergency Interoperability Member Section

Panel 4

- Scott Cadzow – [Standards in Action for e-Health \(e.g. HL7, ISO, OGC\)](#)
- Denise Mckenzie, OGC – [Update on work of the UNGGIM Expert Group](#)
- [John Herring, Oracle](#), Urban Planning DWG

Facilitation for the Summit, a [Background Presentation](#) and a [Closing Presentation](#), provided by OGC Health Domain Working Group co-chairs:

- Dr. Kym Watson, Fraunhofer IOSB; and
- Eddie Oldfield, Spatial Quest Solutions

Appendix 2 - Registered Participants

See: https://portal.opengeospatial.org/public_ogc/register/160621health_view.php