GnosisGIS 2022

International Society for Geospatial Health

Programme

15th International Symposium on Geospatial Health

Naples, Italy
June 28-29 2022

Venue

Centro Congressi Federico II

Symposium Organizers

Sherif Amer, Laura Rinaldi, and Jennifer McCarroll

Scientific Committee

Sherif Amer, Laura Rinaldi and Robert Bergquist

Venue

Centro Congressi Federico II
Via Partenope 36
80121 Napoli

GnosisGIS

International Society of Geospatial Health

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PROGRAMME AT A GLANCE

Monday, June 27, 2022	
7:00 pm	Welcome Reception, Vanilla Café Via Partenope, 12, 80121 Napoli NA, Italy

Tuesday, June 28, 2022	
9:00 am	Spatial Statistics Workshop
12:30 pm	Lunch at Antonio & Antonio Via Partenope, 26, 80121 Napoli NA, Italy
2:00 pm	Opening Session I: Interview with GnosisGIS Founders
2:30 pm	Session II
4:50 pm	Announcements and Closing Day 1
7:00 pm	Conference Dinner Antonio & Antonio Via Partenope, 26, 80121 Napoli NA, Italy

Wednesday, June 29, 2022	
9:00 am	Session III
12:30 pm	Lunch at Antonio & Antonio Via Partenope, 26, 80121 Napoli NA, Italy
2:00 pm	Session IV
4:35 pm	GnosisGIS 2022 Concludes

PROGRAMME IN DETAIL

Tuesday, June 28, 2022	
9:00 am	Spatial Statistics Workshop
12:30 pm	Lunch at Antonio & Antonio
Session I	**Chairperson: Sherif Amer**
2:00 pm	*Welcome*
2:05 pm	*Robert Bergquist, Jack Malone and Thomas Kristensen* Interview with GnosisGIS Founding Fathers
Session II	**Chairperson: Nils Tjaden**
2:30 pm	*Anna-Sofie Stensgaard, University of Copenhagen, Denmark* Mapping the geographical distribution and associated risk factors of *Toxoplasma gondii* sero-prevalence of wild cervid species in Denmark
2:55 pm	*Russell Stothard, Liverpool School of Tropical Medicine, United Kingdom* Bovine schistosomiasis in Malawi: Low-cost GPS tracking of animal movements
3:20 pm	*Break*
3:35 pm	*Eric Delmelle, University of North Carolina at Charlotte, University of Eastern Finland (VIRTUAL)* Rapid surveillance of COVID-19 in the United States using a prospective space-time scan statistic: Detecting and evaluating emerging clusters
4:00 pm	*Ellen-Wien Augustijn, University of Twente, The Netherlands (VIRTUAL)* Towards a Body of Knowledge of Geospatial Health
4:25 pm	*Martina Nocerino, University of Naples Federico II, Italy* Geographical positioning system (GPS) dataloggers and unmanned aerial vehicles (UAVs): GIS-based devices to control cystic echinococcosis in southern Italy
4:50 pm	Announcements and Closing Day 1
7:00 pm	Conference Dinner at Antonio & Antiono

PROGRAMME

Wednesday, June 29, 2022	
Session III	**Chairperson: Anna-Sofie Stensgaard**
9:00 am	*Robert Bergquist, Journal of Geospatial Health, Sweden* A brief overview on the epidemiological utility of the most used satellite instruments
9:25 am	*Nicola Ferre, Istituto Zooprofilatto Sperimentale delle Venezie, Italy* Why should veterinarians need to know about the geographic information standards?
9:50 am	*Nicolas Ray, University of Geneva, Switzerland (VIRTUAL)* Realistic geographic accessibility modeling for better health system planning
10:15 am	Coffee Break
10:45 am	*Carmen Anthonj and Oladapo Hassan, University of Twente, The Netherlands (VIRTUAL)* Water, sanitation, hygiene and waste management in healthcare facilities in Latin America and the Caribbean with focus on Peru. Literature review and geospatial analyses
11:10 am	*Kasandra I.H.M. Poague, University of Twente, The Netherlands* How safe are schools in Brazil during the COVID-19 pandemic? An assessment of water, sanitation and hygiene in COVID-19 clusters
11:35 am	*Frank Osei, University of Twente, The Netherlands (VIRTUAL)* Space-time geostatistical modelling of malaria risk using DHIMS data
12:10 pm	*Open time slot*
12:30 pm	Lunch at Antonio & Antonio
Session IV	**Chairpersons: Robert Bergquist**
2:00 pm	*Jeffrey C. Luvall, NASA Marshall Space Flight Center, USA (VIRTUAL)* Incorporating NASA Earth Science Data into the DHIS2 Health Information System
2:25 pm	*Moara Martins-Rodgers and Prixia Del Mar Nieto, Louisiana State University and Meraki Health, USA and Brazil (VIRTUAL)* Use of soil moisture active passive satellite data (Smap) and Worldclim 2.0 data to predict the potential distribution of visceral lesihmaniasis and its vector *Lutzomyia Longipalpis* in São Paulo and Bahia States, Brazil
2:50 pm	*Verónica Andreo, Instituto de Altos Estudios Espaciales Mario Gulich and Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina (VIRTUAL)* Remotely sensed change detection for the ecological characterization of a Cutaneous Leishmaniasis outbreak"
3:15 pm	*Short Break*
3:25 pm	*Nils Tjaden and Justine Blanford, University of Twente, The Netherlands* Spatio-temporal detection of health risk clusters using local Moran's I as a simple tool for looking ahead during an infectious disease outbreak situation
3:50 pm	Sherif Amer, *University of Twente, The Netherlands* Using routinely collected health records to identify fine resolution spatial patterns of soil-transmitted helminth infections in Rwanda
Session V	**Chairpersons: Robert Bergquist – Sherif Amer – Laura Rinaldi**
4:10 pm	Plenary discussion on possible future directions/activities of GnosisGIS
4:35 pm	Conclusion of GnosisGIS 2022

ABSTRACTS

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Session II

Mapping the geographical distribution and associated risk factors of *Toxoplasma gondii* sero-prevalence of wild cervid species in Denmark

Anna-Sofie Stensgaard[1], Mita E. Sengupta[1], Mariann Chriel[3], Stine T. Nielsen[1,3], Heidi H. Petersen[3]

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Toxoplasma gondii is a zoonotic, protozoan parasite, ranked among some of the most important food-borne parasite globally. In Denmark, antibodies against *T. gondii* in pregnant women has shown to be common, however the prevalence or role of *T. gondii* in wildlife species has never been investigated. To this end, we performed a nationwide survey to estimate and map *T. gondii* seroprevalence and evaluate potential risk factors for seropositivity in wild cervid species hunted for consumption in Denmark. Blood samples were collected from 428 cervids (272 red deer (*Cervus elaphus*), 87 fallow deer (*Dama dama*), 55 roe deer (*Capreolus capreolus*) and 14 sika deer (*Cervus Nippon*) shot during the hunting season October to January 2017 and 2018 at 23 different estates across Denmark, and screened for antibodies against *T. gondii* using a commercial ELISA kits. Environmental and estate management information was obtained via geographical information systems analysis and questionnaire surveys, respectively. A two-level hierarchical modelling approach was chosen to account for clustering of animals within estates. We found an overall seroprevalence of 24.5% (105/428) and a significant difference between the cervid species ($p<0.05$), with odds of sero-positivity being 4.5 times higher in roe deer than fallow deer and 3 times higher in red deer than in fallow deer. Likewise, a significant increase in sero-prevalence was observed with age. Of management factors, only fencing was significantly associated with wild cervid *T. gondii* sero-positivity, with the highest exposure associated with deer from non-fenced hunting areas (OR: 2.21; CI: 1.05-4.99). No significant associations were found with environmental or climatic factors.

To our knowledge, this is the first systematic study of *T. gondii* in wild-living cervids in Denmark. Results indicate that *T. gondii* is endemic and widespread in wild deer populations in Denmark. Apart from being a potential source for human toxoplasmosis in Denmark for humans handling or consuming undercooked game-meat, wildlife may act as sentinels, giving indications of contaminated or "risky" areas.

Bovine schistosomiasis in Malawi: Low-cost GPS tracking of animal movements

Russell Stothard[1], Janelisa MUSAYA[2] and UK-Malawi **HUGS** team

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Background. Tracking bovine schistosomiasis in sub-Saharan Africa has recently grown in importance upon the realisation that hybrid schistosomes found in people likely originated from cattle stocks. In Malawi, both *Schistosoma haematobium-bovis* and *S. haematobium-mattheei* hybrids have been noted but there has been no formal surveillance of bovine schistosomiasis until the **HUGS** (Hybridisation in UroGenital Schistosomiasis) study commenced in April 2021. Furthermore, water contact studies of schistosome infection in African cattle are infrequent.

Objectives. To determine the prevalence of bovine schistosomiasis along Lake Malawi and Upper/Lower Shire River shorelines, with estimation bovine water contact at a transmission focus.

Material and Methods. For estimation of the prevalence of bovine schistosomiasis, cattle were sampled using a miracidia faecal hatching method alongside a parallel study of animal carcasses at abattoir. For cattle water contact studies, a total of 8 GPS data-trackers were available and deployed to all animals within a small, infected and mobile herd identified on the Lake Malawi shoreline. Water contact times and points were measured on site, and remotely, over a 1-month period during which all animals were treated with praziquantel and observed.

Results. From a total of 240 cattle examined using faecal sampling, the prevalence of bovine schistosomiasis along Lake Malawi and Upper Shire River was approaching 60%, some twofold greater than that along the Lower Shire River. At slaughter, adult worms could be found in intestinal mesenteries, with worm burdens ranging from an unpaired male worm up to 300+ adult worm pairs. GPS-tagged animal movements demonstrated daily water contact at several discrete water contact points on the Lake Malawi shoreline. Here, *Bulinus africanus* group snails could be found as well as infected snails noted upon observed shedding schistosome cercariae. DNA characterisation of collected worms, miracidia and cercariae is ongoing.

Conclusion. The **HUGS** study is pursuing a "OneHealth approach" and has now confirmed that bovine schistosomiasis, once previously ignored, is actually common in Malawi. More importantly, cattle schistosomiasis is present in areas where urogenital schistosomiasis in people occurs. Detailed knowledge of cattle watering points and mobile herd husbandry is a fundamental step towards developing an integrated approach to stop emergence of hybrid schistosomes in future.

Keywords: OneHealth, *Schistosoma*-hybrids, water contact, Lake Malawi

Funding source: The Wellcome Trust, UK

Rapid surveillance of COVID-19 in the United States using a prospective space-time scan statistic: Detecting and evaluating emerging clusters

Eric Delmelle[1], Michael Desjardins[2], Alexander Hohl[3]

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[2]Johns Hopkins University
[3] University of Utah

Coronavirus disease 2019 (COVID-19) was first identified in Wuhan, China in December 2019, and is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It is critical to detect clusters of COVID-19 to better allocate resources and improve decision-making as the outbreaks continue to grow.

Using daily case data at the county level provided by Johns Hopkins University, we conducted a prospective spatial-temporal analysis with SaTScan.

We detect statistically significant space-time clusters of COVID-19 at the county level in the U.S. between January 22nd-March 9th, 2020, and January 22nd-March 27th, 2020. The space-time prospective scan statistic detected "active" and emerging clusters that are present at the end of our study periods – notably, 18 more clusters were detected when adding the updated case data.

These timely results can inform public health officials and decision makers about where to improve the allocation of resources, testing sites; also, where to implement stricter quarantines and travel bans.

Towards a Body of Knowledge of Geospatial Health

Ellen-Wien Augustijn, Sherif Amer, Rob Lemmens, Carmen Anthonj

Faculty of Geo-Information Science and Earth Observation, University of Twente, The Netherlands

We present a flexible and incremental development pathway for establishing a collaborative body of knowledge of Geospatial Health under the auspices of GnosisGIS. GI Science and Public Health sciences are both well-established scientific fields, and the interdisciplinary Geospatial Health domain has been growing over the past decades.

We propose the development of an ontology that presents formalized concepts and their interrelationships for Geospatial Health like the EO4GEO Body of Knowledge (BoK)[1] that already exists for GI Science and Earth Observation. Ontologies are valuable tools as they semantically link pieces of information and allow for automated reasoning. There are many use cases of ontologies, including mining of health records.

Several methodologies exist to generate ontologies, including expert-defined ontologies, literature data mining, and there are several ways to reuse existing ontologies. The design of the ontology is defined by the envisioned use/users of the ontology. In the EO4GEO BoK, scientists have been working together to construct the basis for the GI Science ontology. The development of ontologies is iterative and includes cycles of improvement.

The definition of an ontology starts with the definition of top classes (e.g., Visualization) that can be split into subclasses (e.g., Disease diffusion mapping, risk mapping, etc.). Alternatively, a bottom-up approach that defines all components and groups them can be applied. Classes contain properties to be captured, ranging from a name, definition, and literature references to all kinds of other information essential for the ontology users. Tools to visualize these ontologies and create links between ontologies include, e.g., the Living Textbook tool (LTB).

Creating a Geospatial Health ontology would build a shared vocabulary for different scientists and practitioners within the geo-health community. Creating a Geospatial Health ontology will require a step-by-step approach and resources. We initiate this process by building upon the collective Geospatial Health knowledge embedded in the GnosisGIS society and would like every one of you to contribute.

[1] http://www.eo4geo.eu/bok/

Geographical positioning system (GPS) dataloggers and unmanned aerial vehicles (UAVs): GIS-based devices to control cystic echinococcosis in southern Italy

Martina Nocerino[1], Paola PEPE[1], Antonio BOSCO[1], Giuseppe CRINGOLI[1], Laura RINALDI[1], Giorgio de ALTERIIS[2], Claudia CONTE[2,3], Giancarlo RUFINO[2], Domenico ACCARDO[2]

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Background. Cystic echinococcosis (CE), caused by the larval stages of *Echinococcus granulosus*, is a worldwide zoonotic parasitic disease of public health importance, especially in Mediterranean area. The lifecycle involves canids as definitive hosts and mammalians (mainly sheep) as intermediate hosts. In southern Italy the prevalence of CE is up to 75% in sheep and 6% in dogs. In this area, the traditional actions taken against CE are still inefficient since the treatment systems fail to reach inaccessible grazing areas. In addition, climatic changes may influence the epidemiology of CE. In this context, Geograpghical Information Systems (GIS) are useful tools for the development of innovative strategies to control CE.

Objectives. The aim is to explore the use of innovative devices and geospatial techniques to monitor and control CE in southern Italy.

Material and Methods. GPS dataloggers were applied to sheep and dogs, in 5 farms positive to CE. For 1 month, the movements of the animals were tracked to identify the micro-epidemiological channels of the spread of CE in the study area. The collected data were used to locate the specific points for bait distribution. Baits containing Praziquantel were released onto the risk areas by the UAV to deworm stray dogs.

Results. A drone payload was designed on purpose for the release of medicated baits and spatial sampling criteria to improve deworming actions were introduced. In addition, the GPS-based approach was more effective for an accurate identification of spatial patterns of CE than the traditional geospatial approach.

Conclusion. The study confirms the importance of geospatial technology in supporting parasite control strategies and demonstrate that the collection of detailed data regarding the movements and the behavior of the animals, might be a useful method to interrupt the *Echinococcus* lifecycle and to reduce the spread of the disease.

Keywords: Echinococcosis, canids, geospatial data, GPS, drones

Funding source: This research was funded as part of the project "New sustainable tools and innovative actions to control cystic ECHINOcoccosis in sheep farms in the MEDiterranean area: improvement of diagnosis and SAFEty in response to climatic changes - ECHINO-SAFE-MED", supported by PRIMA (Parthernship for research and innovation in the Mediterranean area).

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Session III

A brief overview on the epidemiological utility of the most used satellite instruments

Robert Bergquist

A brief overview on the epidemiological utility of the most used satellite instruments is given. They include the *MODerate resolution Imaging* Spectroradiometer (MODIS) onboard the Terra/Aqua satellites and the dual Thermal Infrared Sensor (TIRS) and the Operational Land Imager (OLI) onboard the latest Landsat missions. A glimpse of the future reflected by the latest dedicated satellite the Soil Moisture Active Passive (SMAP) together with The ECOsystem Space-borne Thermal Radiometer Experiment on Space Station (ECOSTRESS) and the Global Ecosystem Dynamics Investigation (GEDI), both affixed to the international space station (ISS). A selection of commercial ultra-high resolution imagery satellites will also be discussed. The data available do not only support research, but assist also policy makers in making sound decisions concerning environmental protection and disease control.

Why should veterinarians need to know about the geographic information standards?

Nicola Ferre[1], Matteo Mazzucato, Massimiano Bassan, Claudia Casarotto, Diletta Fornasiero, Tiziano Dorotea, Francesca Scolamacchia, Paolo Mulatti

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Background. To facilitate the development, sharing and use of geographic information, GIS specialists use geospatial standards. A geospatial standard is essentially a technical document designed to ensure that materials, products, processes and services are fit for their purpose. Hereby we provide an introduction to geospatial standards that can be used for data interchange in the veterinary domain. As use case, the spatial objects developed to support the avian influence response were analysed to check the fitness, appropriateness and usability of ISO standards to communicate geospatial information.

Objectives. To illustrate the principal ISO standards, which enable the representation and transmission of geographic data to be used as support for animal disease response.

Material and Methods. Data on the HPAI epidemic occurred in Italy between October 2021 and February 2022 were analysed with respect to the relevant ISO standards. The standards considered include: 6709:2008 - Standard representation of geographic point location by coordinates; 19125-1:2004 - Simple feature access — Part 1: Common architecture; and 19157:2013 - Data quality.

Results. Outbreaks location data and the geographical extent of restriction zones were taken into consideration. With few 'extract transform and load' (ETL) operations, the geospatial data can be made fully compatible with 6709 and 19125 standards. No information about data quality was available at the time of analysis; however, a dedicated checklist for data quality evaluation derived from 19157 can be easily defined and associated with the extracted geospatial data.

Conclusion. GIS used to support disease response, surveillance, and monitoring activities has its own procedures, dataset and components. This might create issues when veterinary and publich health spatial data need to be shared between different organisations. An ETL process can be implemented, also with relatively limited qualified resources, to transform legacy data into a ISO-compatible set of data.

Keywords: GIS, ISO TC/211, standards, Avian Influenza

Funding source *[optional]*: European Union's Horizon 2020 research and innovation programme under grant agreement No. 727922 (DELTAFLU)

Realistic geographic accessibility modeling for better health system planning

Prof. Nicolas Ray

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Timely access to adequate health services has long been recognized as an important component of equitable access to health care. While geographic access is not the only factor limiting equitable access to health care, it goes a long way towards explaining spatial inequalities for numerous health services. To ensure realistic output for accessibility metrics, such as population coverage within a given maximum travel time, care must be applied in the way the input geospatial layers and model parameters values are chosen when doing accessibility modeling. In this presentation I will briefly explain the concept behind accessibility modeling and how we seek to increase this realism. I will showcase a series of use cases done in several African countries in support to Ministries of Health and that have allowed to optimize health resource allocation.

Water, sanitation, hygiene and waste management in healthcare facilities in Latin America and the Caribbean with focus on Peru. Literature review and geospatial analyses

Carmen Anthonj [1], Oladapo A. Hassan[1], Kasandra I.H.M. Poague[1], Sherif Amer[1]

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Safe and adequate environmental conditions in health care facilities (HCFs), including the availability of water, sanitation, and hygiene (WASH), waste management, and the availability of standard precaution items (e.g. disposable gloves) are essential to protect and improve the health of patients, health care workers, visitors, and staff. In many low- and middle income countries, the situation on WASH in HCF is deficient, and information and data on gaps remain particularly for Latin American and Caribbean countries.

In response to such information gaps, governments developed the Rural Water and Sanitation Information System to monitor WASH in HCFs, as well as in other non-household, household and community settings. Little analysis of these data has yet been done to present and analyse the situation, and to identify underlying determinants.

Within this research project, we take a comprehensive look at comparable datasets on WASH in HCFs from 11 countries, including Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Honduras, Nicaragua, Mexico, Panama, Paraguay and Peru. We develop an inventory and illustrate the situation and inequalities across geographies, and analyze the sociocultural and environmental determinants of WASH in HCF conditions in selected countries, including Peru.

Ultimately, we derive evidence-based recommendations to consider for improved public health-related planning and decision making.

Key words: Healthcare facility, Health services, Inequalities, WASH, Water and health

How safe are schools in Brazil during the COVID-19 pandemic? An assessment of water, sanitation and hygiene in COVID-19 clusters

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Background. Currently, schools in Brazil are returning with on-site classes in the hybrid model after being closed since March 2020 in the course of the COVID-19 pandemic. Schools in Brazil are known for their limited access to water, sanitation, and hygiene (WASH). The previous paucity of data and research on WASH in schools in Brazil has been preventing an assessment of how safe and healthy schools are to reopen.

Objectives. This study aimed to compare the geographical distribution of COVID-19 incidence and WASH conditions in schools in Brazil and identify possible patterns of association by i) mapping COVID-19 incidence hotspots and coldspots in Brazil; ii) describing and comparing the WASH conditions in schools in the identified clusters.

Material and Methods. Data on WASH conditions in schools in Brazil was retrieved from the 2020 Brazilian National School Census. The Brazilian Ministry of Health supplied data concerning the number of confirmed COVID-19 cases per municipality. Global and Local Moran's I were conducted to identify COVID-19 cluster patterns in Brazil. Descriptive analysis of WASH variables was conducted and compared in COVID-19 incidence hotspots (high-high clusters) and coldspots (low-low clusters). Student's t-test with unequal variances was used to assess the differences between WASH variables in hotspots and coldspots at 5% significance level. Stata, ArcGIS Pro® and GeoDa software were used for data manipulation and spatial analysis.

Results. Findings indicated that schools in COVID-19 incidence coldspots have better drinking water indicators than the ones in hotspots. No differences were found for bathrooms in schools between hot or cold COVID-19 spots and sanitation was better in schools in hotspot areas than in coldspot COVID-19 areas.

Conclusion. Schools in COVID-19 coldspots are more in need of sanitation interventions while schools in COVID-19 hotspots require improvements on the water domain.

Keywords: SARS-CoV-2; WASH; education, Moran's I; hotspot mapping.

Space-time geostatistical modelling of malaria risk using DHIMS data

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Malaria remains a global challenge that continuously affects deprived communities, especially in sub-Saharan Africa. Maps have often been developed based on point reference data from demographic and health survey data. Such data are however not routine, hence updating such maps is not feasible within shorter periods. Most studies either focus on the spatial patterns at a particular point in time or the temporal patterns for an entire geographic area. This is because of data challenges and/or unavailable easy to implement statistical methods. Routine surveillance managed through health information management systems can rather be helpful. Despite such data being routinely collected, they have a poor spatial and temporal resolution. In this study, we sought to develop a space-time geostatistical model to downscale data from the District Health Information Management System (DHIMS). The deterministic components of our model have been captured via a log-linear Poisson model which includes NDVI, LST, NDWI, EVI, Elevation, and precipitation as explanatory determinants. The spatial dependency of the stochastic component is modeled by extending the Poisson semivariogram model into a space-time domain. We observed spatial and temporal trends within lags of 22 km and 5 months, respectively. The leave-one-out cross-validation (LOOCV) is used to assess the prediction accuracy over a 5 km by 5km grid. For our case study area, Ghana, the study observed spatial correlation of malaria risk, reflecting spatial clustering. The spatial clustering is heterogeneous across times/different months. The spatial patterns and clusters are somehow spatially persistent. This study has Developed a spatial statistical framework for space-time prediction of malaria using DHIMS. The method is transferable to other diseases with a similar data structure. Our future work will account for over-dispersion since the Poisson assumption has no variance parameter.

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Session IV

Incorporating NASA Earth Science Data into the DHIS2 Health Information System

Jeffrey C. Luvall[1], John Beck [2], T. Berendes [2], U. Nair,[2] J. Painter[3]

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Background. In malaria endemic countries large amounts of public health resources are devoted to controlling mosquitoes, through insecticide treated bed nets, indoor residual spraying, and eliminating breeding sites. The efficacy of these interventions can be directly influenced by environmental conditions that impact mosquito activity, such as rainfall, temperature and vegetation. Good quality environmental data for these conditions are available through countries with satellite-based earth observations, but the capacity to transfer this data to researchers and public health decision makers is limited.

Objectives. Researchers at UAH in collaboration with the Centers for Disease Control and Prevention (CDC) and NASA propose to improve aims to improve malaria control decision making in sub-Saharan Africa by developing and deploying technology for incorporating the latest NASA Earth observations for surface temperatures, precipitation, and vegetation health into the District Health Information Software 2 (DHIS2) used worldwide, including all sub-Saharan African countries.

Objectives include:

1. Enhanced health decision making for malaria control by integrating the latest relevant NASA Earth observations into an existing decision-making activity
2. Developing and deploying technology solutions that will provide a path to long-term sustainability for the use of NASA Earth observations to end-user health decision makers.

Material and Methods

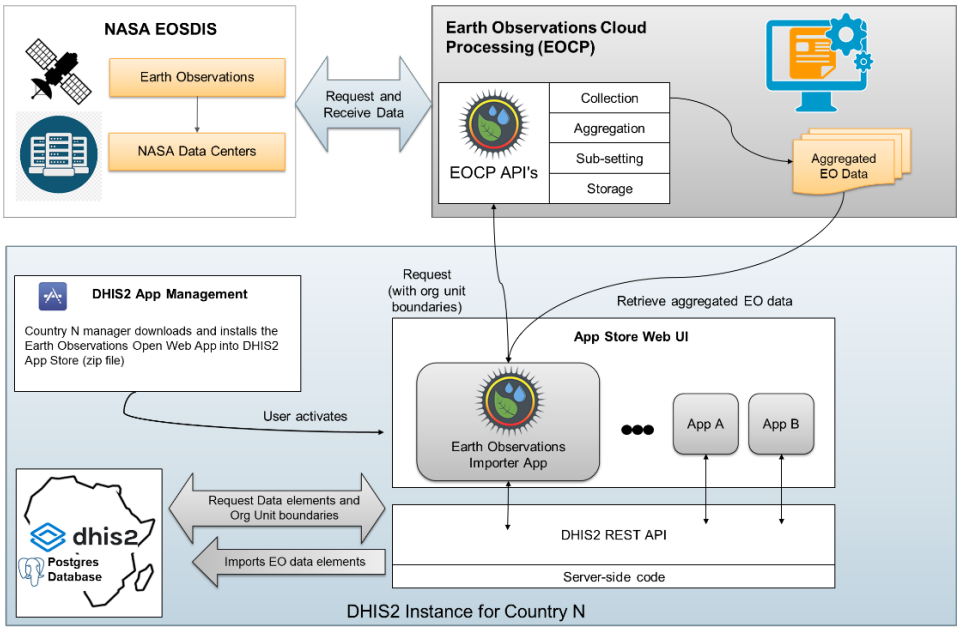

Figure 1. User workflow for incorporating environmental and EOS data into DHIS2.

Results. Adapting the environmental data into the DHIS2 model requires subsetting and aggregation of the data to fit an instance's defined political boundaries. To make the processing easily available to DHIS2 end users, we've developed a DHIS2 app - the Earthdata Importer App - that lets a user request and load environmental data with just a few clicks - without having to be an expert in the processing of that type of data. The data returned through the app can be loaded directly into DHIS2 data elements, making it then available for all the graphs, maps, and other analyses that DHIS2 users typically employ.

Conclusion. Environmental data, from NASA and other sources, tend to not always follow standards or conventions on the structure and format of the data. This can make it difficult for non-environmental experts to work with the data and utilize it for other purposes. The team has been working to provide a well-defined API that supports DHIS2-related requests for NASA data and returns it in a format that can be readily imported into the requesting DHIS2 instance's database.

Keywords: DHIS2, malaria, earth observations,

Funding source: NASA ROSES 2017 A.39 Health and Air Quality

Use of soil moisture active passive satellite data (smap) and Worldclim 2.0 data to predict the potential distribution of visceral lesihmaniasis and its vector *Lutzomyia Longipalpis* in São Paulo and Bahia States, Brazil

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Visceral leishmaniasis (VL) is a neglected tropical disease transmitted *by Lutzomyia longipalpis*, a sand fly species widely distributed in Brazil. Despite efforts to strengthen national control programs for VL, reduction in its incidence and geographical distribution in Brazil is still a challenge. VL is re-emerging and expanding its range to urbanized areas. Ecological niche models (ENM) for use in surveillance and response systems may enable more effective operational VL control by mapping risk areas and elucidating eco-epidemiologic risk factors. ENMs for VL and *Lu. longipalpis* were generated using monthly WorldClim 2.0 data and monthly SMAP L4 soil moisture data. SMAP L4 images from day 1 and day 15 for each month were selected. ENM were developed using MaxEnt software to generate risk maps based on an algorithm for maximum entropy. The jackknife procedure was used to identify contribution of each variable to model performance. The three most meaningful components were used to generate ENM distribution maps in ArcGIS 10.6. Similar patterns of VL and vector distribution were observed using SMAP as compared to WorldClim 2.0 models based on temperature and precipitation data or water budget. Cases of VL and known locations of *Lu. longipalpis* presented similar ENM. A unique match of the VL niche and the surface soil moisture measured by SMAP was observed and defined seasonality regarding soil moisture and precipitation data. Results indicate that direct earth observing satellite measurement of soil moisture by SMAP can be used in lieu of models calculated from classical thermal and precipitation climate station data to assess VL risk.

Keywords: Leishmaniasis, *Lutzomyia longipalpis*, SMAP, ecological niche model, Visceral leishmaniasis.

Financing: NASA

Topic: Epidemiology/Ecoepidemiology

Remotely sensed change detection for the ecological characterization of a Cutaneous Leishmaniasis outbreak" + the same abstract as in the published paper

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In this work we assessed the environmental factors associated with the spatial distribution of a Cutaneous Leishmanaisis (CL) outbreak during 2015-2016 in northeastern Argentina to understand its typical or atypical eco-epidemiological pattern. We combined locations of CL human cases with relevant predictors derived from remote sensing image analysis in the framework of ecological niche modeling. We trained MaxEnt models with cross-validation for predictors estimated at different buffer areas relevant to CL vectors (50 and 250 m radii). To account for the timing of biological phenomena, we considered environmental changes happening in the period 2014-2015 and 2015-2016. The remote sensing analysis identified land cover changes in the surrounding of CL cases, mostly related to a new urbanization and floodings. The distance to such changes was the most important variable in most models. The weighted average map denotes higher suitability for CL in the outskirts of Corrientes city and areas close to environmental changes. Our results point to a scenario consistent with a typical CL outbreak, i.e., changes in land use or land cover are the main triggering factor and most affected people live or work in border habitats.

Keywords: Cutaneous Leishmaniasis, remote sensing, land use and land cover change, species distribution models, disease ecology

Spatio-temporal detection of health risk clusters using local Moran's I as a simple tool for looking ahead during an infectious disease outbreak situation

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During a global health crisis like the COVID-19 pandemic, situational awareness among decision makers and public health authorities is paramount. From early on in the pandemic, simple geographical tools like interactive dashboards displaying choropleth maps of case numbers and incidences were heavily utilized to assess the current situation. At the same time, epidemiological models of increasing complexity were developed in an attempt to predict future developments – with varying amounts of success. Here, we investigate the use local Moran's I as an intermediate complexity alternative for these two applications. As local Moran's I is an established method available in all major GIS applications, it could be used and understood relatively easily by a broader audience. Using spatio-temporal data of COVID-19 in the Netherlands, we show that maps built upon local Moran's I can help assessing the current situation by identifying areas of high concern more clearly than maps of bare case numbers or incidence rates. We also investigate if creating these maps in the early phase of rising case numbers can help to anticipate spatial patterns of disease prevalence at the peak of the upcoming wave of infections. Finally, we address the question whether recent efforts to incorporate temporal aspects into the otherwise purely spatial local Moran's I must be incorporated.

Using routinely collected health records to identify fine resolution spatial patterns of soil-transmitted helminth infections in Rwanda

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Abstract

Introduction. Soil-transmitted helminths (STH) are parasitic diseases with significant public health impact. Analysis is generally based on cross-sectional prevalence surveys; outcomes are mostly aggregated to larger spatial units. However, recent research demonstrates that infection levels and spatial patterns differ between STH types and tend to be localized.

Methodology. Incidence data of STHs including roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworms per primary health facility for 2007-2008 were linked to spatially delineated primary health centre service areas. Prevalence data per District for individual and combined STH infections from the 2007/2008 nationwide survey in Rwanda were also obtained.

Results. A comparison of reported prevalence and incidence data indicated significant positive correlations for roundworm (R^2= 0.63) and hookworm (R^2= 0.27). Weak positive correlations were observed for whipworm (R^2=0.02) and the three STHs combined (R^2= 0.10). Incidence of roundworm and whipworm were found to be focalized with significant spatial autocorrelation (Moran's I > 0: 0.05 – 0.38 and p ≤ 0.03.), with (very) high incidence rates in some focal areas. In contrast, hookworm incidence is ubiquitous, randomly distributed (Moran's I > 0: 0.006 and p= 0.74), and with very low incidence rates. Furthermore, an exploratory regression analysis identified relationships between helminth infection incidences and potential environmental and socio-economic risk factors.

Conclusion. Findings show that the spatial distribution of STH incidence is significantly associated with soil properties (sand proportion and pH), rainfall, wetlands and their uses, population density and proportion of rural residents. Identified spatial patterns are important to guide STH prevention and control programs.