GnosisGIS 2023

International Society for Geospatial Health

Program

16th International Symposium on Geospatial Health

Enschede, The Netherlands
November 13 – 16, 2023

Venue

Faculty of Geo-Information Science and Earth Observation
University of Twente

Langezijds Building
Hallenweg 8
7522 NH Enschede

The campus offers a free internet service for visitors: 'Enschede Stad van nu'

Symposium Organizers

Sherif Amer, Laura Rinaldi, Robert Bergquist, Justine Blanford, Ellen-Wien Augustijn, Carmen Anthonj, Frank Osei, Marloes Penning de Vries, Caroline Kioko, Nils Tjaden, Petra Weber, Lise-Lotte Smit-Westerhof, Job Duim (….and many others that have actively contributed)

Venue

Faculty of Geo-Information Science and Earth Observation
University of Twente
Langezijds Building
Hallenweg 8, 7522NH Enschede

GnosisGIS

International Society of Geospatial Health

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PROGRAM AT A GLANCE

Monday 13 November		
Time	**Activity**	**Location**
09:00 – 10:30	Workshop Agent-based models	LA - 1235
10:30 – 11:00	Coffee	ITC lounge (2203)
11:00 – 12:30	Workshop Agent-based models	LA - 1235
12:30 – 13:30	Lunch	ITC lounge (2203)
13:30 – 15:00	Workshop spatial statistics	LA - 1235
15:00 – 15:30	Coffee	ITC lounge (2203)
15:30 – 17:00	Workshop spatial statistics	LA - 1235
17:30 – 19:00	Icebreaker	Theater cafe UT

Tuesday 14 November		
Time	**Activity**	**Location**
09:00 – 09:30	Registration	LA - 2209
09:30 – 09:45	Welcome speech	LA - 2209
09:45 – 10:15	Keynote	LA - 2209
10:30 – 11:00	Coffee	ITC lounge (2203)
11:00 – 12:30	Presentations: Session 1	LA - 2209
12:30 – 13:30	Lunch – Posters	ITC lounge (2203)
13:30 – 15:00	Presentations: Session 2	LA - 2209
15:00 – 15:30	Coffee	ITC lounge (2203)
15:30 – 17:00	Presentations: Session 3	LA - 2209
17:30 – 19:00	Welcome reception	ITC lounge

Wednesday 15 November				
Time	**Activity**		**Location**	
09:00 – 10:00	Panel discussion		LA - 2209	
10:00 – 10:30	(extra time for panel discussion if needed, else poster pitches)		LA - 2209/ITC Lounge	
10:30 - 11:00	Coffee		ITC lounge (2203)	
11:00 – 12:30	Presentations: Session 4		LA - 2209	
12:30 – 13:30	Lunch – Posters		ITC lounge (2203)	
13:30 – 15:00	Parallel session			
	Presentations: Session 5 (online)	Tour of ITC GeoLabs	LA - 2209	-
15:00 – 15:30	Coffee		ITC lounge (2203)	
15:30 – 17:00	Presentations: Session 6		LA - 2209	
17:00 – 17:15	Awards & Closing		LA - 2209	
17:30 – 20:30	Conference dinner		U Parkhotel	

Thursday 16 November1		
Time	**Activity**	**Location**
09:00 – 10:30	Match-making session	LA - 2310
10:30 - 11:00	Coffee	ITC lounge (2203)
11:00 – 12:30	Ontology for Geospatial Health session	LA - 2310

12:30 – 13:30	Farewell lunch	The Gallery

PROGRAM IN DETAIL

TUESDAY 14 NOVEMBER

Time	Activity	Location: LA - 2209
09:00	Registration	
09:30	Welcome speech – Prof. Freek van der Meer, Dean of ITC	
09:45	Keynote – Prof. Justine Blanford, Chair ITC Geohealth	

10:30	Morning Coffee	ITC lounge

Presentations Session 1 – Chair: Sherif Amer		LA – 2209
11:00	*Carmen Anthonj, ITC - University of Twente, The Netherlands.* Capturing and addressing challenges of health promotion among marginalized groups.	
11:15	*Nima Yaghmaei, KIT Royal Tropical Institute, The Netherlands.* Utilizing Geospatial Methods to Drive Health Service Delivery in the Era of Climate Change.	
11:30	*Martina Nocerino, Department of Veterinary Medicine and Animal Production, University of Naples Federico II, Italy.* Tracking the movements of sheep and shepherd dogs for a new control strategy of cystic echinococcosis in grazing areas of southern Italy.	
11:45	*Michael Ward, Sydney School of Veterinary Science, The University of Sydney, Australia.* Spread of the first varroa mite (Varroa destructor) incursion in Australia and the role of landscape.	
12:00	*Behzad Kiani (online), UQ Centre for Clinical Research, Faculty of Medicine, The University of Queensland, Australia.* Associations between gentrification, census tract-level socioeconomic status, and cycling infrastructure expansions in Montreal, Canada.	
12:15	*Ori Gudes (online), The University of New South Wales, Australia.* Geospatial Analysis of Child Development Assessment Services in a Socially Vulnerable Region of Sydney.	

12:30	Lunch – Posters pitches	ITC lounge

Presentations Session 2 – Chair: Carmen Anthonj		LA – 2209
13:30	*Ellen-Wien Augustijn, ITC - University of Twente, The Netherlands.* Towards a better spatial and temporal understanding of the pollen allergy burden.	
13:45	*Taye Bayode, Heidelberg University and Heidelberg University of Education, Germany.* Modelling urban spatial structure and malaria: Empirical analysis from medium-sized city of Akure, Nigeria.	
14:00	*Sarsenbay Abdrakhmanov, S. Seifullin Kazakh Agro Technical Research University, Kazakhstan.* Rabies in the Republic of Kazakhstan: spatial and temporal characteristics of disease spread over one decade (2013–2022).	
14:15	*Bart Roelofs, Faculty of Spatial Sciences, University of Groningen, The Netherlands.* Mapping the space, time & scale of disease. A decision tree for selecting the appropriate technique for mapping disease data.	
14:30	*Yao Etienne Kouakou (online), Nangui Abrogoua University and Centre Suisse de Recherches Scientifiques, Côte d'Ivoire* Using the IPCC-AR5 methodological framework to assess malaria risk in relation to climate change in Côte d'Ivoire.	
14:45	*Paulo Gabriel da Silva Mota (online), Federal University of Rondonópolis, Brazil.* Geospatial epidemiology of leprosy and cutaneous leishmaniasis coinfection in Central-Western Brazil.	

15:00	Afternoon Coffee	ITC lounge

Presentations Session 3 – Chair: Nils Tjaden		LA – 2209
15:30	*Yersin Mukhanbetkaliyev, S. Seifullin Kazakh Agro Technical Research University, Kazakhstan.* Development of a digital database of epidemically significant veterinary objects in the Republic of Kazakhstan.	
15:45	*Suhyb Salama, ITC - University of Twente, The Netherlands.* Augmented Intelligence for Sustainable Water and Health.	
16:00	*Marloes Penning de Vries, ITC - University of Twente, The Netherlands.* Water hyacinths: Use them or lose them? A holistic approach to a multi-faceted problem.	

16:15	*Caroline Kioko, ITC - University of Twente, The Netherlands.* Emerging vector-borne and zoonotic infections in the Twente-Achterhoek Region: A GeoTechMed Approach.
16:30	*Cllinton Nkolokosa (online), Malawi-Liverpool-Wellcome Programme, Malawi* First report of the intermediate host snail for Schistosoma mansoni, Biomphalaria pfeifferi, in the lower Shire, southern Malawi.
16:45	*Jeffrey Luvall (online), NASA Marshall Space Flight Center, USA* NASA's NextGen Remote Sensing Instruments Have be Announced: Implications for Public Heath.

17:30	Welcome reception	ITC lounge

WEDNESDAY 15 NOVEMBER

Time	**Activity**	**Location**
09:00	Panel discussion	LA - 2209
10:00	(extra time for panel discussion if needed, else poster pitches)	

10:30	Morning Coffee	ITC lounge

Presentations Session 4 – Chair: Ellen-Wien Augustijn		LA – 2209
11:00	*Mélanie Droogleever Fortuyn, 510, an initiative of the Netherlands Red Cross, The Netherlands.* Towards understanding cholera risk and predicting epidemic scenarios to enable anticipatory action in Cameroon.	
11:15	*Alan Juache, Avia-GIS, Belgium* The characterization of Urban Dengue Hotspots and Cold Spots in Lucknow (India) and how these may affect disease transmission.	
11:30	*Nicola Lattero, Department of Veterinary Medicine and Animal Production, University of Naples Federico II, Italy.* New sustainable tools and innovative actions to control cystic echinococcosis.	
11:45	*Iuria Betco, Instituto de Geografia e Ordenamento do Território, Portugal* Sentiment analysis using a lexicon: the case of Lisbon.	

12:00	*Ram Raghavan, Department of Veterinary Pathobiology, College of Veterinary Medicine, University of Missouri, USA.* Dynamic Occupancy Approach to identify Chronic Wasting Disease Spatiotemporal Patterns.
12:15	*Stella Gachoki, ITC - University of Twente, The Netherlands* Transferability of tsetse habitat models between different regions in Kenya and Rwanda.

12:30	Lunch – Posters pitches	ITC lounge

Presentations Session 5 – Chair: Murali Krishna Iyyanki, ISPRS WG III/9 Geospatial Environment and Health Analytics	**Online parallel session**
13:30	*Mahbuba Nasreen, Bangladesh Open University, Bangladesh.* Reproductive Health during Disasters: an intersectional analysis from Bangladesh.
13:45	*Suchi Gopal, Boston University, USA.* Opioid Mortality in the US: Quantifying the Direct and Indirect Impact of Sociodemographic and Socioeconomic Factors.
14:00	*Seema Jalan, Department of Geography, Mohan Lal Sukhadia University, India* Geospatially Informed Assessment of Universal Health Coverage: An Example Regarding Distribution of Rural Health Facilities from Rajasthan, India.
14:15	*Ugonna Nkwunonwo, Department of Geoinformatics and Surveying* *Faculty of Environmental Studies, University of Nigeria Enugu Campus, Nigeria.* Navigating the COVID-19 pandemic and new normal: a critical appraisal of the contributions of geographical information system.
14:30	*Murali Krishna Iyyanki, JN Technological University Hyderabad, India.* Remote sensing as an exposomic measurement tool for pulmonary diseases management.
14:45	-

15:00	Afternoon Coffee	ITC lounge

Presentations Session 6 – Chair: Caroline Kioko		LA – 2209
15:30	*Marcos César Ferreira (online, prerecorded), Institute of Geosciences, University of Campinas, Brazil.* The relationship between network centrality measures and the incidence rate of COVID-19 in cities of southeastern Brazil.	
15:45	*Joseph Emanuel (online), Department of Statistics, University of Missouri Department of Veterinary Pathobiology, USA.* Methods in R-Language and Python for Geospatial Covariate Extractions over Space-Time.	
16:00	*Joseph Mosley (online), Department of Veterinary Pathobiology, University of Missouri – Columbia, USA.* Spatial-Temporal Interactions to Predict Probability of Chronic Wasting Disease Distribution.	
16:15	Elias Nyandwi, University of Rwanda, College of Sciences and Technology, Centre for Geographic Information Systems and Remote Sensing, Rwanda. Community-based precision mapping of Schistosomiasis: the experience of Rwanda.	
16:30	*Nils Tjaden, ITC - University of Twente, The Netherlands.* The power of interactive maps for communicating spatio-temporal data to health professionals.	
16:45	*Frank Badu Osei, ITC - University of Twente, The Netherlands.* A Marginalized Zero-Inflated Spatially Varying Coefficient Model for Disease Modeling.	
17:00	Best Presentation Award & Closing of Presentation Sessions	

17:30 – 20:30	Conference dinner	U Parkhotel

THURSDAY 16 NOVEMBER (further details will follow)

Time	**Activity**	**Location**
09:00	Match-making session	LA - 2310
10:30	Coffee	ITC lounge

11:00	Ontology for Geospatial Health session	LA - 2310
12:30	Farewell lunch	The Gallery

ABSTRACTS

The following list of abstracts is sorted in alphabetical order of the first author (which is not in all cases the presenter). Poster abstracts are separately listed at the end of the document.

Geospatial Health: evolving scientific orientation and thematic content 2006 - 2023

Amer, S.[1] and Augustijn, E.-W.[1]
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Presenting author: Sherif Amer [s.amer@utwente.nl]

Background. *Geospatial Health* is an international, peer-reviewed scientific journal produced by the International Society of Geospatial Health (GnosisGIS). The society was established in 2000, and the journal's first issue was published in 2006. The journal's scope is to address all aspects of geographical information system (GIS) applications, remote sensing and associated methods and techniques, including both human and veterinary health. This study illustrates how the scientific orientation and thematic contents have developed over time, covering the period between 2006 and 2023. Our analysis is both timely and significant for two reasons. First, it illustrates how *Geospatial Health* has matured and diversified over time. Second, it, at least in part, mirrors how geoinformation science and associated technologies have progressed in addressing global health problems.

Objective. The study aims to illustrate how the journal Geospatial Health has scientifically developed over time in terms of health problems, geographic focus, geospatial methods and techniques, and scientific impact between 2006 and 2023.

Method. Or methodology relies on text mining, the process of automatically examining large collections of, in our case, bibliometric data. The complete bibliometric dataset of *Geospatial Heath* – covering 730 scientific publications - was extracted from Web of Science for the period 2006 – 2023. Most of the analysis is based on keyword co-occurrence relations using the VOS-viewer software. Other parts of the analysis have been done using standard analytical functionality offered by Web of Science. To adequately identify changes over time, the analysis compares four time periods: 2006 – 2010, 2011 – 2015, 2016 – 2020, and 2021 – 2023.

Results. The content analysis of all publications shows how the scientific orientation and thematic contents of articles in the Geospatial Health journal have evolved. In the initial stages, there was a very strong focus on vector-borne diseases, especially on schistosomiasis and malaria, and to a lesser extent on leishmaniasis and fascioliasis. Over time, the scope of health problems addressed broadens with increasing attention for noncommunicable diseases such as cancer, obesity, and cardiovascular disease. Covid-19 was a hot topic in the period 2012-2023. The geographic focus of studies also evolves over time. In the initial years, emphasis was mainly on Africa (33%) and Asia (25%); over time, the share of Asia has grown considerably (61%) while that of Africa (6%) has sharply declined. The affiliation country of authors is consistently dominated by the USA, with an increasing share of China. More recently, Indonesia, Malaysia, and Thailand remarkably increased. Italy and Switzerland were initially very well represented, but their share has declined since 2015. The scientific impact of the journal has been relatively stable over time, with a current impact factor of around 1.7 (2023). Further investigation is ongoing on the changing use of geospatial methods and techniques.

Conclusions. Our study illustrates how *Geospatial Health* has matured over time in terms of a broadening scientific scope, shifting geographic focus, increasing use of state-of-the-art geospatial methods and techniques, and associated stable scientific impact.

Capturing and addressing challenges of health promotion among marginalized groups

Anthonj, C.[1*], Flacke, J.[1], Stanglow, N.S.[2], Poague, K.I.H.M.[1], Jendrek, S.[2], Grunwald, N.[2]
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Presenting author: Carmen Anthonj [c.anthonj@utwente.nl]

Background. Health-promoting infrastructure, such as drinking water, sanitation and hygiene (WASH) and related health benefits are widely enjoyed in high-income countries. WASH is closely related to housing, and its management the responsibility of property owners. Marginalized population groups, including people experiencing homelessness sleeping rough, in encampments or in shelters in urban areas, are often excluded. For hundreds of thousands of homeless people in Europe, homeless shelters and public toilets are sometimes the option to access appropriate health-promoting infrastructure. Despite the high societal relevance according to the United Nations Sustainable Development Goal 6 to "ensure water and sanitation for all", and despite the human right to water and sanitation, the needs of people experiencing homelessness are not yet fully met; WASH inequalities and the resulting burden of disease remain hidden and under-researched, particularly in high-income countries.

Method. With our ongoing exploratory study we aim to (i) understand challenges of health promotion that people experiencing homelessness are facing, and (ii) identify solutions to address these challenges. Data are being collected in Bonn, Germany, from and with people experiencing homelessness with different methods (in-depth walking interviews, photovoice, mental maps, arts-based research workshops and group discussions, participatory mapping), from their service providers (social workers), and from public urban drinking water, sanitation an hygiene infrastructure based on spot checks, combining approaches from social sciences, public health, planning and geography. The target group of this research, people experiencing homelessness, is involved throughout the research.

Results. Preliminary results of mapping health-promoting infrastructure indicate the undersupply of publicly accessible drinking water dispensers, toilets and showers. Preliminary findings of interviews with people experiencing homelessness and their social workers highlight a variety of challenges related to WASH insecurity, and exposure to associated health risks. Our insights point not only to the urgent need of improving access to health-promoting infrastructure for marginalized population groups, and underline the importance of involving those at risk, and those in a position to change the situation. They also show difficulties of working in data-scarce contexts with a population group as vulnerable and mobile as people experiencing homelessness, and the implications and complications for planning, and the choice of data collection tools.

Conclusions. Our high risk, high gain research project has several novelties. It (i) considers WASH and health challenges in an understudied marginalized target group, (ii) provides the first evidence on water and health insecurity experiences among people experiencing homelessness in Germany, (iii) combines and integrates two knowledge gaps on WASH among homeless people and climate-resilient public WASH in urban areas, (iv) employs a citizen science approach and (v) further develops a participatory planning and mapping tool and inclusive co-design approach in a novel context.

Towards a better spatial and temporal understanding of the pollen allergy burden

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Presenting author: Ellen-Wien Augustijn [p.w.m.augustijn@utwente.nl]

Climate change is altering the timing of recurring biological events such as the leaf unfolding or flowering of plants. These alterations, in turn, impact planetary and human health in both direct and indirect ways. Regarding the latter, we see that diseases are re-emerging or appearing in new locations, or there is an increase in the disease burden they cause. For example, due to an earlier start of flowering of allergenic trees and grasses over the past years, the pollen season is shifting, and hay fever has become less predictable.

To increase our understanding of the complexity of providing relevant and robust pollen information to hay fever patients, a multidisciplinary consortium joined forces in the KAPPA project that started on the 1st of January 2022 with funding from Care Research Netherlands (ZonMW). The consortium brings together healthcare specialists (Leiden University Medical Centre, Elkerliek Hospital, Service Pharmacy), governmental organizations working on health (National Institute for Public Health and the Environment (RIVM), Municipal public health service (GGD) Rotterdam), the business sector (Knowledge Centre for Trees and Soils (Terra Nostra)), and universities (Wageningen University & Research and the University of Twente).

Here, we present part of the outcomes of the KAPPA project. In particular, we focus on studying the spatial temporal patterns of the burden of pollen allergies. To do so, we analysed data from different sources, including:

- Registered records of patients with allergy complaints collected by general practitioners in the Leiden-Den-Haag region of the Netherlands.
- Over-the-counter medication from 300 drugstores located in the Netherlands.
- Pollen counts from two Dutch counting stations (Leiden and Helmond).
- Air quality data available via luchtmeetnet.nl.
- Weather information from different sources.

We analyse eight different species, including birch, alder and grasses and 44-year pollen counts time series from pollen stations in the Netherlands. To increase the understanding of spatio-temporal patterns (differences in the timing of pollen allergies in different regions of the Netherlands), we use a clustering approach (Self-Organizing Maps) to delineate regions with similar sales patterns. SOMs were applied on sales time series segments that overlap with different species' pollen emission periods. The initial results show a good alignment between peaks of pollen emission for birch and grasses and peaks of sales. We also found a large variation between the different years, especially in spatial sales clusters.

Modelling urban spatial structure and malaria: Empirical analysis from medium-sized city of Akure, Nigeria

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Background. The last two decades have witnessed enormous revolution in applications of spatial science tools to city management and development. Particularly, due to improved software computational capabilities, hardware, and ubiquity of very high resolution (VHR) earth observation or fine scale data. Despite these many advantages, cities in low and middle – income countries lag in the study and modelling of the city spatial form and how it impacts health of city dwellers. This study therefore investigated the nexus between urban spatial structure and urban malaria mong children below five years (U5) in a rapidly growing medium-sized city of Akure, Nigeria.

Method. First, we modelled and classified the urban structure of Akure based on building morphological characteristics such as building size, building orientation and density using Momepy tool in python. Based on the obtained four classes (informal settlement, medium density settlement; formal/planned settlement; peri-urban settlement), we randomly selected four neighbourhoods from each class, upon which we aggregated the burden of U5 malaria. Second, we employed analysis of variance (ANOVA) to statistically determine the difference in the mean of U5 malaria among the settlement classes.

Results. The study shows that U5 malaria varies significantly among the settlement classes ($p = 1.118e-05$) with highest difference between peri-urban settlement and medium density settlement ($p = 0.0000988$). There's no difference between planned and medium density settlement; informal and medium settlement ($p = 0.3091361$; $p = 0.1440773$). The study further shows that the highest burden of U5 malaria is associated with the peri-urban settlement.

Conclusions. Thus, this research outcome provides a directional platform upon which social and environmental investigation can be carried out for the study area.

Sentiment analysis using a lexicon: the case of Lisbon

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Presenting author: Iuria Betco [betcoiuria@edu.ulisboa.pt]

Background. The last decade has seen a growing interest in computational methods for measuring affect, namely Opinion Mining, Subjectivity Detection, Sentiment, and Emotion Analysis. These methods focus primarily on identifying opinions, emotions, sentiments, evaluations, beliefs, and speculations. While Subjectivity classification labels text as objective or subjective, Sentiment Classification adds a level of granularity by classifying subjective text as positive, negative, or neutral, which in turn is refined by Emotion Analysis by identifying the presence of emotions, such as joy, anger, fear, and other. Sentiment Classification techniques can be divided into: Machine Learning Approach; Lexicon Based Approach; and Hybrid Approach.

Method. This study aims to automatically identify the sentiments expressed in comments posted by users of the social network Twitter in the city of Lisbon, using a sentiment lexicon, i.e., a list of words manually labelled with positive (e.g., fun) and negative (e.g., sad) polarity. Subsequently, it was possible to calculate the overall sentiment score for each post. The advantage of this method is that it does not require training data, as is the case with the supervised machine learning method. We used the NRC Word-Emotion Association Lexicon (EmoLex) for the sentiment analysis. This lexicon has a list of English words associated with eight basic emotions (anger, fear, anticipation, trust, surprise, sadness, joy, and disgust) and two sentiments (negative and positive). In addition to sentiment analysis, we also conduct some work on computational analysis of the emotional content of text using emotion lexicons. The EmoLex classifies terms with Plutchik's eight basic emotions because these basic emotions are well grounded in psychological, physiological, and empirical research; they are not composed of primarily negative emotions as found in Ekman; and because it is a superset of the emotions proposed by some of the basic emotion theories.

Results. Through the sentiment analysis, it was possible to verify that the areas with a high score of words associated with the positive sentiment (]150 - 800]) cover the stores and restaurants of Avenida da Liberdade, Praça Dom Pedro IV (Rossio Square), Elevador de Santa Justa, Armazéns do Chiado, Rua Augusta, and Aeroporto Humberto Delgado. With a moderate score (]150 - 800]) are covered MAAT, Doca de Santo Amaro, Centro de Congressos de Lisboa, Village Underground Lisboa, LxFactory, SUD Lisboa, Jardim Guerra Junqueiro (Jardim da Estrela), Centro Comercial do Colombo, Centro Comercial Vasco da Gama, Altice Arena and Feira Internacional de Lisboa (FIL).

Conclusion. It can be concluded that the Portuguese are happy in spaces associated with leisure and consumption, such as museums, event spots, gardens, shopping centers, stores, and restaurants.

Geospatial epidemiology of leprosy and cutaneous leishmaniasis coinfection in Central-Western Brazil

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Presenting author: Paulo Gabriel da Silva Mota [paulo.gabriel@aluno.ufr.edu.br]

Background. Leprosy and cutaneous leishmaniasis (CL) are neglected tropical diseases that are difficult to control in Brazil. Although they share some biological, clinical and epidemiological features, the coinfection leprosy/CL is poorly addressed in the country. A better comprehension of this association may be useful for the integration of leprosy and CL control programs in target areas, which has been recommended as a way to improve case-detection and timely treatment. Therefore, this ecological study identified spatial patterns related to the occurrence of leprosy/CL coinfection in the state of Mato Grosso—a hyperendemic area for both diseases in Central-Western Brazil.

Method. First, we performed a probabilistic linkage procedure between leprosy (n=27,790) and CL (n=24,357) databases of the national reporting system and identified 414 individuals diagnosed with both diseases from 2008 to 2017. From these individuals, leprosy/CL coinfection was considered when the date of diagnosis of leprosy or CL was between the date of diagnosis of the first disease and the date of discharge. The cases of coinfection were grouped according to the municipality of residence. The cumulative incidence of coinfection was mapped for each municipality. Using a negative binomial multivariate regression, we modelled the number of cases of coinfection by municipality as a function of the cumulative incidence of leprosy and CL with the population count as an offset term. Finally, the Kulldorff's spatial scan statistic was employed to identify high-risk areas for the coinfection at the municipality level.

Results. In the study period, 64 cases of leprosy/CL coinfection were observed in the state of Mato Grosso, which corresponds to a cumulative incidence of 0.2 cases/100,000 inhabitants. Almost 30% (40/141) of the municipalities reported at least one case of the coinfection; *Alta Floresta* (n=4) and *Barra do Bugres* (n=4) led the records. The cumulative incidence varied widely among municipalities (range: from 0.0 to 5.4 cases/100,000 inhabitants). The highest rates were observed in the northern and northeastern municipalities. An increase in the cumulative incidence of leprosy (beta=0.005; p=0.006) and CL (beta=0.003; p=0.017) was associated with an increase in the number of cases with leprosy/CL coinfection at the municipality level. We detected two high-risk clusters for the coinfection encompassing 33 and 16 northern (relative risk—RR=3.7; p<0.001) and northeastern (RR=4.36; p=0.016) municipalities, respectively.

Conclusion. In conclusion, leprosy/CL coinfection occurs with a considerable frequency in the state of Mato Grosso. The more endemicity for leprosy and CL, the more cases of coinfection are observed. The municipalities located in the North and Northeast regions represent hotspots for the coinfection. Therefore, these areas must be target of public policies aimed at integrating leprosy and CL surveillance and control actions, especially the continuous training of the professional team of the primary healthcare facilities.

Dynamic Occupancy Approach to identify Chronic Wasting Disease Spatiotemporal Patterns

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Background. Chronic Wasting Disease (CWD) is a neurodegenerative prion disease of cervids whose incidence among white-tailed deer has steadily increased over the years in N. America since mid-60s. The disease is transmitted by a misfolded protein (prion) that is transmitted vertically and horizontally among deer, shed in urine and other biological materials, can remain active in soil for up to 2.5 years and re-infect deer. Various environmental factors are suspected to be associated with the risk of CWD among deer but broad scale geospatial analysis to identify such associations are seldom found in the literature

Objective. Our objective was to use a dynamic occupancy model to quantify the spatiotemporal spread of CWD and potentially identify geospatial covariates that are associated with the presence of CWD over the landscape.

Method. We used retrospective data and surveillance data on CWD presence from 2005 till 2023 in Kansas, and fitted a discrete-time, dynamic, patch dependent occupancy model in a Bayesian framework to detect probability of CWD presence in a 20x20km grid over space and time. Additionally we estimated the rates of spread, and construct linkages between land cover/land use, soil, and landscape metrics as covariates. Covariates were extracted for a 5km area surrounding locations were deer were harvested from the National Land Cover Database and USDA SSURGO datasets.

Results: The average probability of CWD occupancy increased in northwest are of the study region from a low 0.08 in 2008 to a high of 0.61 in 2019. The probability of predicting CWD if it is present in a given 20x20km grid within a year was 0.22 (95% Credible Interval: 0.19, 0.24). The

sodium adsorption ratio (SAR) was a significant predictor of CWD presence in a grid, and as SAR increased, the probability decreased. Elevation, another significant predictor increased as CWD increased within a given grid.

Conclusions. The identification of geospatial determinants for CWD in the study region is significant and allows for the development of management strategies. Cutting edge geospatial and modeling approaches are necessary to successfully identify associations of environmental drivers with wildlife diseases.

Methods in R-Language and Python for Geospatial Covariate Extractions over Space-Time

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The spatiotemporal distributions of wildlife diseases are closely linked with environmental and climatic factors. As such, a number of these "drivers" have explanatory potential, and in an epidemiological context they can be interpreted as "risk-factors" of these diseases. Chronic Wasting Disease is a prion disease affecting cervids (ex. white-tailed deer), present in over 30 states and provinces in North America as well as Scandinavian countries. Various geospatial factors, such as land cover and soil type/condition have been suggested to impact the spread of the disease. Wildlife disease data are often imbalanced, and understanding the associations with these factors is complicated and require a robust geospatial framework for rapid covariate data extraction, management and parallel-processing of statistical models. We developed a number of programming routines in R-language as well as Python to address this critical need. We demonstrate by utilizing the "*sp*", "*sf*", and "*raster*" "*exactextractr*" R-packages, among others, covariate extractions corresponding to reported disease locations can be either summarized by ad-hoc areal units and/or specific locations on a given geographic space. In addition, preliminary statistical studies have revealed that extreme class imbalances in spatiotemporal disease data may also be addressed with random sampling schemes on areal sub-groups. Continued development of our data pre-processing along these lines could help mitigate these issues and allow us to identify a stronger signal from the geospatial covariates. Further, these routines are readily coupled with machine learning (ML), statistical diagnostic and interpretative methods (e.g., Gaussian Process Boosting, Generalized Additive Model, Zero-Inflated Poisson Model, and Log Gaussian Cox Method) for determining strength of covariate associations and patterns of spatiotemporal distributions.

The relationship between network centrality measures and the incidence rate of COVID-19 in cities of southeastern Brazil

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Background. COVID-19 was declared a pandemic by the World Health Organization (WHO) on January 11, 2020, and it spread rapidly around the world, reaching several countries, including Brazil. Due to problems such as the poor public health management by the Brazilian government, high contagion rate and rapid mutations of the SARS-CoV-2 virus, COVID-19 spread spatially throughout the Brazilian territory, and has resulted in 37,796,956 cases and 705,172 deaths as of September 27, 2023. Several factors have been associated with COVID-19 morbidity, such as age and poverty, among others. In addition to these local determinants, factors related to the spatial diffusion of the SARS-CoV-2 virus, caused by population mobility, could also contribute to the increase in the number of cases. Human mobility results in the introduction of pathogens by infected travellers from other locations. For this reason, network-based approaches have been used in research on the spread of diseases.

Objectives. This study aimed to evaluate the correlation between spatial network centrality measures (NCMs) and the incidence rate of COVID-19 in cities in the region of São José do Rio Preto (RSJRP), located in the state of São Paulo, southeastern Brazil. This region comprises 109 cities and had a high average incidence rate of COVID-19 (10,860 cases per 100,000 inhabitants), higher than the Brazilian average of 9,378 cases per 100,000 inhabitants.

Method. Data on the incidence rate of COVID-19 (INC) in the RSJRP region, accumulated through July 10, 2021, were used. The connection links between the cities were drawn from the road map of the state of São Paulo. The nodes of the network were identified on the map of urban centres in the state of São Paulo. Edge and node spreadsheets were imported into Gephi software, and then the following NCMs were calculated: degree (DEG), betweenness (BET), closeness (CLO) and eigenvector (EIN). Then, the correlation coefficients between the NCMs and INC were estimated.

Results. The results showed that the EIN centrality measure presented the highest positive correlation with the incidence rate of COVID-19 ($r=0.377$; $p<0.001$), followed by the DEG ($r=0.284$; $p=0.003$) and BET ($r=0.190$; $p=0.049$) measures. Cities with high EIN values are usually

close to the best-connected cities in the network. This may also explain the occurrence of higher INC values in these cities. Even though these cities are smaller, their proximity to well-connected cities can make them vulnerable to virus importation.

Conclusions. Cities with high DEG values have a large number of roads that lead to them. For this reason, these cities may be the travel destination of people who are infected with the virus, increasing the possibility of introducing the contagion to the noninfected local population. Higher BET values are associated with cities that are crossed by a large number of short paths, and therefore, they are gateway nodes between cities that are not directly connected to each other. Therefore, they can be intermediate bridges between larger cities, where high incidence rates occur.

Transferability of tsetse habitat models between different regions in Kenya and Rwanda

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Background. Accurate and reliable information on the distribution of tsetse habitats is crucial for the effective management of African Trypanosomiasis in sub-Saharan Africa. However, conducting large-scale surveillance of tsetse flies to develop distribution maps is impractical due to vast areas infested and limited resources available.

Method. To address this challenge, we evaluated the applicability of tsetse habitat models developed in the intensively sampled Shimba Hills National Reserve in Kenya for both the wet and the dry season, to two other regions in Kenya (Ruma National Park and Nguruman Conservancy) and one region in Rwanda (Akagera National Park). The models utilized satellite-based estimates of vegetation greenness, land cover, and land surface temperature, combined with tsetse occurrence data, to predict habitat suitability. An independent dataset of tsetse occurrence was used to benchmark the performance of the transferred models.

Results. The performance of the transferred models was significantly influenced by the similarity in environmental conditions between the model's development area and the transfer area. In regions with high dissimilarity, such as Nguruman Conservancy during the dry season, model transfer was unsuccessful with an F1-score of zero. In all other regions and seasons, the transferred models showed satisfactory performance, with F1-score values exceeding 0.65. Nevertheless, site-specific models outperformed (>0.8 F1-score) the transferred models, indicating that models specifically developed with data for each location can provide more accurate information on tsetse distribution.

Conclusions. In conclusion, our study demonstrates that tsetse habitat models can be transferred with relatively good accuracies to seasons and regions that exhibit environmental similarity with the model training area. Despite the higher accuracy of site-specific models, transferring models to similar sites remains a meaningful exercise in the absence of detailed surveillance data.

Opioid Mortality in the US: Quantifying the Direct and Indirect Impact of Sociodemographic and Socioeconomic Factors

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This study looks at how various social and economic aspects impact opioid death rates throughout the U.S. We used a spatial Durbin model that takes into account not only information from individual states but also the connections between them. Our research covered 49 states over six years, from 2014 to 2019. We discovered that opioid death rates depend on two main factors: (i) The characteristics of the state itself, like the age and racial makeup of its population (direct effects). (ii). The characteristics of nearby states (indirect effects or what happens in one state spilling over to affect another). Interestingly, these indirect effects or "spillovers" seem to play an even bigger role than the direct ones. Our approach in this study can serve as a model for other research, where understanding the spatial spillovers from one area to another is important, especially in studying widespread public health issues.

Geospatial Analysis of Child Development Assessment Services in a Socially Vulnerable Region of Sydney

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Background. Neurodevelopmental disorders (NDD) are on the rise, and understanding the geographic distribution and access variables of child developmental services is crucial. Prolonged wait times for developmental assessments can significantly impact care and outcomes.

Aims. This study aims to geospatially analyse the profile and access to publicly funded child developmental assessments following the streamlining of clinical governance processes in a socially vulnerable region of Sydney.

Methods. We extracted data for 2354 patients from the Child Development Assessment Service (CDAS) dataset over a four-year period (2018-2022). Socio-Economic Indexes for Areas (SEIFA) were obtained from the Australian Bureau of Statistics (ABS). We employed descriptive statistics to analyse demographic data and various geospatial techniques to examine the relationships and factors affecting wait lists.

Results. The median age of the children was 51 months (IQR 41-61), with 73.7% being males. Among the children, 64% came from culturally and linguistically diverse backgrounds (CALD), and 10.1% had at least one social vulnerability factor in addition to CALD. Nearly half of the patients resided in the most disadvantaged suburbs. One-third of the children were diagnosed with Global Developmental Delays (GDD), and 53% had Autism Spectrum Disorders (ASD). While the median wait time was 302.5 days (IQR 175-379), 25% of children were assessed within 6 months. CALD patients and children over 5 years of age had shorter wait times ($p<0.001$; $p<0.004$, respectively). Most children with GDD were from the lowest four SEIFA deciles and experienced longer wait times. Approximately 42.6% of children were seen either within the same priority allocated at the time of referral or earlier. Children with ASD and/or severe and profound GDD were prioritized for earlier assessments.

Conclusions. This geospatial analysis approach sheds light on the profile, prioritization, and wait lists of children served by CDAS in South Western Sydney, a region characterized by high social vulnerability. The findings provide guidance for benchmarking targets and underscore the continued need to prioritize children from socioeconomically disadvantaged areas. Public investment in child development assessment services is imperative to enhance access to assessments for these children. Further geospatial analyses at a suburban level are required to formulate targeted strategies for improving service accessibility.

Towards understanding cholera risk and predicting epidemic scenarios to enable anticipatory action in Cameroon

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Background. Cholera is an acute diarrhoeal disease and a significant public health challenge in Africa. Cameroon has experienced cholera outbreaks since 1971. From mid-June 2022 to mid-June 2023, 19,087 cholera cases were reported, with 1,880 confirmed cases and 450 recorded deaths (meaning a 2.4% fatality rate). Preparedness and response are vital for preventing or minimising the impact of cholera. A part of preparedness is anticipatory action for which an early warning system to trigger early actions is required. This research focuses on constructing a risk index and predictive model for cholera.

Method. Our methodology for the construction of the geospatial cholera risk index is based on the INFORM equal weighting framework. The cholera risk index consists of climatic, environmental, and socio-economic factors: precipitation, temperature, population density, surface water amount, poverty, conflicts, WASH facilities and population per health care facility. The cholera risk index is validated by correlating the index with the cholera incidences. We obtained yearly cholera cases and deaths at the regional level.

Results. Our results showed that cholera risk is more prominent in the southern regions of Cameroon. The validation with the limited amount of incidence data (over two years) showed that not all indicators identified in the literature are relevant to cholera incidences in the context of Cameroon. If more historical and higher resolution incidence data is available, the validation can be improved. Future research consists of developing a spatialized metapopulation model accounting for age and spatial distribution of the population in the country. This model will give us information on the dynamics of potential cholera epidemics scenarios.

Conclusions. The resulting cholera incidence scenarios in at-risk areas of Cameroon may allow us to define an optimal epidemiological threshold and to inform the early actions to be implemented after this threshold is surpassed.

Geospatially Informed Assessment of Universal Health Coverage: An Example Regarding Distribution of Rural Health Facilities from Rajasthan, India

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The efficacy of delivery, utilization and impact of health services in a country is a function of the capacity of health system and infrastructure to provide accessible, affordable, equitable and quality care. India has a three-tiered public health care structure. A hierarchical network of sub-centers (SCs), primary health centers (PHCs) and community health centers (CHCs), with increasing levels of staff strength, specialization, services and infrastructure in that order, are the three pillars of Primary Health Care System in the country.

The 3rd Sustainable Development Goal (SDG) mandates 'good health and well-being' for all. Universal access to essential public health-care services is a pre-requisite for realization of the targets set forth under the Goal. In India, particularly the State of Rajasthan, disparities in access to health care facilities has been one of the primary challenges especially in socio-economically backward rural areas where lack of road infrastructure, public and personal transport facilities, and quality private medical facilities are lacking. A pilot study has been undertaken in Tonk region of Rajasthan to assess the distribution of rural public health facilities in context of norms laid down under Indian Public Health Standards (IPHS). The location of SCs and PHCs has been mapped and analysed in terms of uniformity of distribution, distance from demand points (population) and service providers (facilities), and service area in terms of population and geographical area. Over-served and under-served areas have been identified at village level in terms of distance to nearest health facility. Priority areas for location of new facilities have been identified. Nearest Neighbour Index has been used for spatial pattern analysis, Near and Buffer analysis have been employed for estimating the service areas.

Results indicate that the distribution of public health facilites in the study area far from satisfactory. The spatial distribution of SCs is random and that of PHCs is dispersed with high disparity in terms of service area and population served. The service area of SCs ranges from less than 20 sq. km to more than 60 sq. km. Further the population served by SCs ranges from less than 1000 to more than 10000 persons. The service area of PHCs also ranges from less than 40 to more than 80 sq. kms. Notably, all the rural PHCs serve less than 20000 persons, which is significantly below the IPHS threshold of 30000. The panchayats located in Todaraisingh panchayat samiti are relatively underserved lacking adequate PHCs as well as SCs, and have to travel long distances for medical needs. The southern and eastern parts located in Tonk panchayat samiti are more favoured.

The study demonstrates a simple yet effective geospatial approach to monitor, analyse and supervise easy, equal and optimal access to health care facilities at grass root level in context of the 3rd SDG. The proposed geospatial decision support system can enable informed decision making for effective implementation of National Health Mission through demand driven health care planning and establishment of health care facilities in underserved and disadvantaged areas.

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The characterization of Urban Dengue Hotspots and Cold Spots in Lucknow (India) and how these may affect disease transmission

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Background. Dengue fever is one of the most prevalent arboviral diseases in India. It is a major concern to public health since its transmission could be exacerbated by several factors including climate change. In this study, we evaluated the seasonality and clustering pattern of geo-referenced dengue cases reported in 2021 and 2022 in Lucknow, Uttar Pradesh, India. The clustering pattern of dengue cases was analyzed weekly, at ward level, through the Getis-Ord Gi* statistic. The consistency of wards assigned as hot or coldspots between years was examined using the Fuzzy Kappa statistic. Finally, we compared sociodemographic (total number of households and illiterates per area), landcover (built-up areas, vegetation, tree cover), and climatic (Temperature and the Urban Heat Index) covariates between wards assigned as hot or coldspots using the Mann-Whitney U test. Our results indicate that, in both years, dengue transmission follows a similar pattern; case build-up starts at the end of the monsoon and the maximum peak is reached at the end of October (2021) or at the start of November (2022); finally, it drops by the end of December. The weekly Getis-Ord Gi* revealed that eastern and southern wards of Lucknow are consistently classified as hotspots whereas more central wards are as coldspots. Comparing the covariates between groups showed that hotspots as opposed to coldspots have statistically lower temperatures and higher relative humidity, are less densely built, have more tree cover and vegetation, and harbor a lower number of households and illiterates per area unit. Whilst it is important to stress that our results are descriptive and not predictive in time, they show a consistent clustering pattern in which eastern and southern wards served as transmission foci in 2021 and 2022. In addition, highly significant differences related to sociodemographic, landcover, and climatic covariates were found between high and low risk areas, indicating which type of wards would be more likely to become hotspots or cold spots in a city such as Lucknow. We discuss how the observed patterns may relate to vector survival

and disease transmission and could be used to support dengue monitoring and management in Lucknow and how this may be affected by climate change in future.

Associations between gentrification, census tract-level socioeconomic status, and cycling infrastructure expansions in Montreal, Canada

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Background. Cycling infrastructure investments support active transportation, improve population health, and reduce health inequities. This study examines the relationship between changes in cycling infrastructure (2011-2016) and census tract (CT)-level measures of material 35 deprivation, visible minorities, and gentrification in Montreal.

Methods. Our outcomes are the length of protected bike lanes, cyclist-only paths, multi-use paths, and on-street bike lanes in 2011, and change in total length of bike lanes between 2011 and 2016 at the CT level. Census data provided measures of the level of material deprivation and of the percentage of visible minorities in 2011, and if a CT gentrified between 2011 and 2016. Using a hurdle modelling approach, we explore associations among these CT-level socioeconomic measures, gentrification status, baseline cycling infrastructure (2011), and its changes (2011-42 2016). We further tested if these associations varied depending on the baseline level of existing infrastructure, to assess if areas with originally less resources benefited less or more.

Results. In 2011, CTs with higher level of material deprivation or greater percentages of visible minorities had less cycling infrastructure. Overall, between 2011 and 2016, cycling infrastructure increased from 7.0% to 10.9% of the road network, but the implementation of new cycling infrastructure in CTs with no pre-existing cycling infrastructure in 2011 was less likely to occur in CTs with a higher percentage of visible minorities. High-income CTs that were ineligible for gentrification between 2011 and 2016 benefited less from new cycling infrastructure implementations compared to low-income CTs that were not gentrified during the same period.

Conclusion. Montreal's municipal cycling infrastructure programs did not exacerbate socioeconomic disparities in cycling infrastructure from 2011 to 2016 in CTs with pre-existing infrastructure. However, it is crucial to prioritize the implementation of cycling infrastructure in CTs with high populations of visible minorities, particularly in CTs where no cycling infrastructure currently exists.

Emerging vector-borne and zoonotic infections in the Twente-Achterhoek Region: A GeoTechMed Approach

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Background. Climate change has led to the emergence of new and sometimes unexpected zoonotic infections in new locations. However, due to a lack of awareness many cases remain undiagnosed or misdiagnosed, posing a potential threat to public health and healthcare costs. Timely insight into the known regional prevalence of vector-borne and zoonotic infections may lead to more targeted diagnostics in daily practice. Knowing where and when such infections are taking place can inform the public of potential risks and will support physicians in diagnosis and treatment of the newly emerging in the region as a consequence of climate change. In our study we aimed to gain insight how climate might affect changes in disease transmission dynamics in the Twente-Achterhoek Region, the Netherlands. Methods: We examined trends in zoonotic disease prevalence in the Twente-Achterhoek Region between 2016- 2023. We obtained environmental data (daily temperature and rainfall data; land use data) and disease prevalence data for the same time period. Preliminary analysis of the lab data revealed four key diseases. We mapped the distribution of zoonotic diseases across space and time using regional diagnostic data and created risk maps using environmental data based on known ecology

for the vectors and rodents. We cross-compared known distributions of laboratory diagnoses with environmental-based risk maps and assessed how risk patterns changed over time.

Results. The main diseases prevalent in the study area were those transmitted by rodents (hantavirus and leptospirosis) and ticks (Lyme and Tick-borne encephalitis). The maps revealed distinct environmental risk patterns. By understanding these patterns over time, we were able to identify key areas where emerging zoonotic infections risk would be more and less likely to occur.

Conclusions. Our GeoMedTech approach to zoonotic infections will offer new insight in the occurrence and spread of vector-borne and rodent-related zoonotic infections, and into how this relates to climate change. In the future, this insight can be used to develop a MedTech innovation to support better targeted diagnostics and thereby prevent under- and misdiagnosis of zoonotic infections.

Using the IPCC-AR5 methodological framework to assess malaria risk in relation to climate change in Côte d'Ivoire

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Introduction. Malaria, the leading cause of morbidity and mortality in Côte d'Ivoire, has a heterogeneous geographical distribution due to considerable variations in the country's four climatic zones: Attiéen (zone I), Baouléen (zone II), Soudanais (zone III) and Montagnes (zone IV).

Aim. The aim of this article was to apply the concept of climate risk developed by the IPCC in its 5th Assessment Report (AR5) to the assessment of malaria risk in children under 5 and pregnant women in the 14 administrative districts of Côte d'Ivoire.

Methods. The annual rainfall and the mean annual temperature were used as indicators to characterize the climatic hazard. The most exposed groups considered were pregnant women and children under 5. For vulnerability, five indicators were considered, including one for sensitivity and four for adaptive capacity. A participatory approach based on expert judgement was adopted to assign weights to each of the indicators of the three components of risk : hazard, exposure and vulnerability. Future malaria risk was assessed using optimistic (rcp4.5) and pessimistic (rcp8.5) scenarios to 2050.The risk values obtained were classified according to a nominal scale ranging from "very low" (0) to "very high" (1).

Results. This study shows that malaria risk among pregnant women and children under 5 varies from Low (0.3) in climatic zone III (Savanes district) to Intermediate (0.55) in climatic zone IV (Montagne district). Analysis by risk component shows that climatic hazard is High (0.68) in climatic zone IV and exposure is Very High (0.83) in climatic zone I (Abidjan district). Vulnerability is Intermediate in climate zones II (Sassandra Marahoué district), I (Comoé district) and IV (Montagnes district). By 2050, the rcp4.5 scenario predicts an increase in scores from Low (0.35) in the Denguele district (Zone III) to High (0.61) in the Montagnes district (Zone IV). The risk will vary from Low (0.29) to Intermediate (0.56) for rcp8.5 scenarios. This scenario presents a level of risk almost identical to the current level, with the exception of some districts in climatic zones I, II and III, where the risk falls slightly from its current level.

Conclusion. The Montagnes district (zone IV) presents the highest level of risk and is therefore the priority zone for intervention. It also important to carry out prevention actions such as early warning systems in the Attiéen climate zone (zone I), mainly in the district of Abidjan, characterized by the highest exposure of pregnant women and children under 5 years of age, in order to reduce the risk.
Key words. West Africa, exposure, danger, malaria, vulnerability, health.

New sustainable tools and innovative actions to control cystic echinococcosis

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The aim of this study is to show the potential of GIS-based innovative tools to support control strategies against cystic echinococcosis in highly endemic areas.

Cystic echinococcosis (CE), caused by the larval stage of the cestode *Echinococcus granulosus*, has a worldwide distribution and is considered one of the most important zoonotic diseases of grazing sheep in the Mediterranean region. In this area, the traditional actions taken to control CE are still inefficient, because surveillance and treatment strategies fail to reach inaccessible grazing areas (accessible to stray canids) and

are usually designed for wide geographical areas without considering that the prevalence of CE can differ widely in different locations of the same region.

The use of GPS equipment makes it possible to track animal (sheep and dogs) movements and identify the most frequented locations within grazing areas. Furthermore, application of anthelmintic baits (laced with praziquantel) using unmanned aerial vehicles (UAVs) allows development of treatment strategies specifically designed for capillary and automatic distribution of anthelmintics in study areas, minimizing waste of time and resources. Further innovative devices to implement the control of CE are camera traps to continuously monitor the stray canids for praziquantel-laced baits.

These innovative tools and technologies have been successfully used in southern Italy to implement control of CE within the actions of the Echino-Safe-Med project.

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NASA's NextGen Remote Sensing Instruments Have be Announced: Implications for Public Heath

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NASA is designing a new set of Earth-focused missions to provide key information to guide efforts related to climate change, disaster mitigation, fighting forest fires, and improving real-time agricultural processes. The Surface Biology Geology (SBG) mission will collect global remote sensing measurements using a hyperspectral spectrometer and multispectral thermal data. These data sets will provide a significant enhancement in our ability to study disease vector ecology globally. Global public health is entering a new information age through the use of spatial models of disease vector/host ecologies driven by the use of remotely sensed data. Currently, instruments on the International Space Station (ISS)-ECOSTRESS (Thermal), DESIS (hyperspectral) and GEDI (lidar) are currently providing data sets that can be immediately used for public health applications and prepare the community for using SBG data products.

Spatial-Temporal Interactions to Predict Probability of Chronic Wasting Disease Distribution

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Chronic Wasting Disease (CWD) is a widespread infectious degenerative prion disease affecting captive and wild species of cervids (ex. white-tailed deer). It is present in over 30 states and provinces in North America, along with now most Scandinavian countries. Prior research suggests environmental factors (landscape, soil) may assist in the spread/sustainment of the disease, and further research is needed to understand how the disease spreads spatially beyond human-assisted means. In Kansas, these variables differ across multiple regions and presents challenges to disease surveillance and mitigation. Such heterogeneous geospatial factors, i.e., soil, land cover/land use, and landscape metrics are potential predictors for the disease. We constructed Generalized Additive Models (GAM) along with geospatial covariates derived from the USGS, and USDA-NRCS to evaluate the strength of associations with disease status. Additionally, spatial and temporal smooth functions were added to adjust for spatial/temporal autocorrelation in the GAM construct. Our analyses indicate that spatial locations (latitude and longitude) of animal locations is a significant driver for this disease (*P*-value: $<2e^{-16}$). The random effects models adequately discriminated true positives and negatives (AUC = 0.958 and 0.956). The model performance across the state and regionally did well which allow for further model fitting with landscape covariates to explain what proportion of the distribution is influenced by those covariates. Our geospatial models will include variables such as proximity of harvest locations to streams of Strahler stream orders 1-9 and waterbodies in the landscape, in addition to soil and landscape properties. Our initial analyses reveal that for stream orders 9 with annual flow, 24% of total positives are within 250 meters of the waterway compared to only 14% of negatives in the state, showing a distinct pattern in spatial heterogeneity for positives. This suggests that the disease probability rates are at least partially defined by the spatial heterogeneity and further refinement of environmental covariates (e.g., appropriate size and varying units of analysis, higher resolution geospatial data, etc.) are required. Additionally, analysis at a regional scale which share common geospatial features (e.g., watershed) may help identify geospatial covariate associations.

Development of a digital database of epidemically significant veterinary objects in the Republic of Kazakhstan

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To ensure the sustainable development of the agro-industrial complex and the safety of agricultural products in Kazakhstan, a project is being implemented to create a digital database of agricultural objects on the territory of the Republic. The territory of Kazakhstan has historically been considered unfavorable for many infectious diseases, common to humans and animals. Therefore, objects that humans use in livestock breeding and in the processing of animal products can potentially be the link where the pathogen, directly or through transmission factors, can be transmitted from animals to humans and vise versa. Therefore, the definition and identification of "epidemiologically significant veterinary objects" will enable compiling a unified register of data on such objects, with their characteristics and the degree of potential danger for subsequent use in planning anti-epizootic measures. There are four main categories of epidemically significant objects:

1. Agricultural (farms and other livestock-related producers, processing enterprises, slaughterhouses)
2. Veterinary (livestock burial grounds, veterinary clinics, biological enterprises)
3. Utilities (landfills, markets, exhibitions)
4. Other (transport hubs, hunting grounds, landscape anomalies - swamps, etc.)

For the period from February 1 to August 31, 2023, a series of expeditionary trips to all regions of the country have been undertaken, which resulted in creation of electronic databases of livestock facilities related to pig breeding (N =2537), sheep breeding (N = 2478), horse breeding (N = 2411) and slaughterhouses (N = 156). The databases include geographically referenced locations of farms with livestock population numbers, as well as livestock markets, fairs, slaughterhouses, and meat processing plants. Existing data are already being used to conduct spatial epidemiology studies aimed at assessing the risk of infectious diseases in farm animals (African swine fever, Peste des petits ruminants, Equine viral rhinotracheitis). Using remote sensing data, work is being performed to identify the proximity of epidemically significant objects to grazing areas for farm animals.

This work is a pilot project for Kazakhstan and provides a significant contribution to the development of digitalization of agriculture and veterinary services, ensuring a transition to automation of the decision-making process in the field of ensuring the health of animals and people.

This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19678128)

Keywords. Kazakhstan, veterinary medicine, One Health, remote sensing, digital farms

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Rabies in the Republic of Kazakhstan: spatial and temporal characteristics of disease spread over one decade (2013–2022)

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Rabies is a fatal zoonotic disease that remains endemic and presents a serious public concern in Kazakhstan despite the implementation of annual vaccination campaigns. Wildlife species or dogs can serve as reservoirs for rabies and spill over into livestock and humans. This results in two epidemiological cycles for disease transmission, referred to as wildlife, sylvatic, or rural, and domestic animal or urban, respectively. Both cycles overlap, sometimes, in locations and periods of time when wild life species and dogs co-exist. Under certain conditions, they may be exacerbated by changes of human activities and climate change.

Using data collected over a 10-year time period, the objectives of this study were: to provide updated information on the epidemiological situation of the disease in the country, to identify spatial clusters of rabies cases stratified per group of susceptible species, and to characterize those clusters.

A database including all confirmed animal rabies cases reported in Kazakhstan between 2013 and 2022 was obtained from the Committee for Veterinary Control and Supervision of the Ministry of Agriculture of the Republic of Kazakhstan. Rabies cases were grouped into one of three possible categories, depending on the affected species, as livestock (cattle, horses etc.), companion (dogs and cats), or wild life (foxes, wolves etc.). Spatial clusters of cases were identified using the multinomial model of the spatial scan statistic, implemented in the SatScan software. This model detects those clusters, in which the number of cases observed for each category (livestock, companion, wildlife) was significantly higher than the expected under the null hypothesis of even distribution of cases per category in space.

Five significant ($p<0.05$) clusters of disease were detected. Clusters in southern Kazakhstan were associated with companion animals, which are likely explained by the maintenance of a domestic cycle of the disease in the most densely populated region of the country. Livestock

cases were most frequent in clusters in the eastern (where wildlife cases were also frequent) and western regions of Kazakhstan, with higher probability of occurrence in spring and summer, compared to the rest of the year.

The results provide quantitative evidence that supports the hypothesis of alternative transmission cycles (urban in the south, rural in the east and west) in the country. The findings will contribute to the design and implementation of zoning approaches to support the progressive control of rabies in the country within a regional initiative, which is being implemented by the members of an informal network MEEREB (Middle East, Eastern Europe and Central Asia countries).

This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19679670).

Reproductive Health during Disasters: an intersectional analysis from Bangladesh

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Disasters are common phenomenon in the South Asian region. Within South Asia, Bangladesh has been identified as one of the most vulnerable countries due to her geophysical characteristics. With a diverse geography Bangladesh possesses hilly and low-land *haor* areas in the north and plain land almost the rest part with a low-land coastal area in the south. The country is labeled as 'riverine Bangladesh' as it is situated in the Ganga-Brahmaputra-Meghna basin and enriched with a wider river-network. Large number of rivers is lying throughout the country. The coastal zone is composed of 19 sea-facing districts and nearly 600 kilometers of coastline. The rivers and canals significantly contribute to the livelihoods people in the agriculture-based economy at the same time they bring sufferings of millions in the form of frequent floods, river bank erosion, waterlogging, landslides. In the coastal zones cyclones are also frequent phenomenon in Bangladesh. Waterborne diseases and other health related global crises, such as Covid 19, have also been experienced by affected people.

Although disasters affect all segments of population, they have differential impacts on multiple categories in the highly stratified gendered economics and culture. In general women, especially in the poorer categories, suffer from poverty, hunger, malnutrition, economic crises, environmental degradation, health related problems, insecurity and become victim of violence, which become intensified during disasters. Reproductive health of women during disasters and emergency suffers more than other crises. COVID-19 pandemic caused disruptions in the socio-economic, health and psychological stands for all categories of people. However, the outcome of pandemic also falls disproportionate on women and men.

The paper is based on the findings of three different studies conducted in both rural and urban areas over different periods of time using mixed-method approach. It has combined both primary and secondary sources of information. Quantitative and qualitative data have been collected from different locations of Bangladesh.

The study findings indicate that disasters and Covid-19 pandemic cause severe impacts on reproductive health of women, especially on poorer categories living in disaster prone areas. The were deprived of essential maternal healthcare services (MCHs), which is a crucial requirement of reproductive health. Research conducted using intersectional less, identified that there was no or less effective services even during common disasters and during Covid 19 these were almost absent. The study identified that that effective policy interventions and implementation strategies should be developed in context of providing maternal health care services, identifying causes for lower access to MCHs, gender-specific vulnerabilities experienced by healthcare workers and caregivers and relevant others during disasters including pandemic. The findings also suggested for a decentralized disaster risk management approach, disaster–risk livelihoods linkages and understanding gender and intersectionality-based resilience to reducing vulnerability during and post disaster and pandemic situations.

First report of the intermediate host snail for *Schistosoma mansoni*, *Biomphalaria pfeifferi*, in the lower Shire, southern Malawi

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A time-based malacological survey was conducted in Chikwawa and Nsanje districts of lower Shire, Malawi. Data on occurrence and abundance of *Biomphalaria pfeifferi* snails, conductivity, pH, temperature and total dissolved solids (TDS) of water and elevation were obtained across 45 sampled semi-aquatic habitats. Subsequently, *B. pfeifferi* presence or absence was predicted using the physicochemical and environmental conditions in a random forest classification to determine the abiotic factors associated with their occurrence. Furthermore, the rDNA sequences of the detected *B. pfeifferi* were obtained for further identification. We established the presence of *B.* pfeifferi populations in Chikwawa. Primary finding from the Templeton Crandall and Sing network is that the Chikwawa District haplotype is identical to one haplotype also found in Mangochi District (GenBank

Accession number: OQ216746) as well as Zimbabwe (GenBank Accession number: MG780180). This suggests introduction into Chikwawa may have come from either Mangochi District (Mangochi District snails potentially descended from Zimbabwe snails. Primary finding from molecular xenomonitoring screen suggests that *S. mansoni* may be being transmitted in this area, however larger-scale assessment is needed. Among the explanatory variables, conductivity and TDS of water and elevation were more important in increasing accuracy of the prediction model. The results suggest that *B. pfeifferi* spatial presence across lower Shire is influenced strongly by conductivity, TDS of water, and elevation. Temperature and pH of water play a slightly less significant role in mediating the occurrence of *B. pfeifferi* occurrence in the lower Shire. Ascertaining the whereabouts and understanding the environmental determinants of *B. pfeifferi* occurrence in the lower Shire are critical steps in the implementation or redesign of appropriate and effective focal intestinal schistosomiasis control strategies.

Navigating the COVID-19 pandemic and new normal: a critical appraisal of the contributions of geographical information system.

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Nearly three years have elapsed since the COVID-19 pandemic surfaced. Its impact on the global community's lifestyle, demography and economy is gradually fading into history as more and more individuals recover from losses and adapt to the new reality or new normal. Though the new normal is rife with significant uncertainties and sustainability concerns. To tackle these concerns, further research is needed to advance the idea of geospatial science as an *intelligent nervous system*, vis-à-vis the COVID-19 and post-COVID-19 regimes. This study conducts a synthesis and critical analysis of the literature on the roles played by geographic information system (GIS), its components, and spatial analyses techniques in characterising the coronavirus disease, formulating practical solutions for populations to navigate the peaks of infections and fatalities, and enabling populations to adapt to the new normal. SCOPUS-indexed journals, GIS Bibliography, Litcovid, PubMed, Environmental science and other databases were searched for articles covering January 2020, to September 2023. Studies that met the predefined inclusion and exclusion criteria are profuse and highlight a robust correlation between GIS and COVID-19 epidemiology, including contact tracing, trend and pattern of spread, case fatalities, disease's hotspots. GIS played a significant role in the COVID-19 era, with a flurry of scholarly contribution marked by epistemological nuances and complexities involving novel conceptualisations, dynamic modelling schemes, and the use of advanced mathematical, statistical, and cartographic tools. While ongoing research explores how GIS can aid populations in adapting to the new normal, the post-COVID-19 era offers a distinctive scenario and a fresh research perspective, significantly expanding the integration of GIS in medicine.
Keywords. COVID-19 pandemic, Coronavirus, GIS, New normal, Uncertainty, Sustainability, Post-Covid-19, Intelligent nervous system

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Tracking the movements of sheep and shepherd dogs for a new control strategy of cystic echinococcosis in grazing areas of southern Italy

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Background. Cystic echinococcosis (CE) is one of the most severe parasitic zoonosis, caused by the larval stages of *Echinococcus granulosus*. The lifecycle of *E. granulosus* involves canids as definitive hosts and usually sheep and other herbivore species as intermediate hosts. CE has a worldwide distribution but exhibits the highest prevalence in communities where pastoral activities predominate, as the Mediterranean areas (Deplazes et al. 2017). Free-roaming dogs (owned and unowned) are the major source of echinococcosis and the most challenging category in dog population management for the control of CE (Kachani et al. 2014). New sustainable tools are needed to implement the efficiency of CE control programmes, especially for definitive hosts. In this regard, the combined use of Geographical Information Systems (GIS) and innovative devices (e.g., GPS collars) could be a useful tool to identify the spatiotemporal patterns of the free-roaming owned dogs and design new treatment strategies for wild canids.

Objectives. The spatial analysis performed in this study aimed to define the mean daily walking distances travelled by sheep and shepherd dogs, their spatio-temporal activity patterns and home range areas.

Methods. In 5 farms positive to CE, 1 sheep and 2 shepherd dogs were tracked for 1 month using 15 GPS wearable devices. A Multiple Ring Buffer analysis was conducted to estimate the distance of sheep and dog point locations from the farms, then spatial and temporal data were compared to determine their movement patterns. The home range areas were calculated performed using the Minimum Convex Polygons considering the 100% of the space used by the animals. Points for the delivery of praziquantel-laced baits for the treatment of wild canids were fixed on the boundaries of the home range areas.

Results. The mean daily walking distance travelled not significantly differ between sheep and dogs in the farms monitored. The extended home range areas ranged from 51 to 250ha. The farthest distances from the farms (1,500mt) were travelled between 10.00 and 17.00. New schemes for the delivery of medicated baits on the study area were designed.

Conclusion. This study confirms the importance of geospatial technology in supporting parasite control strategies and demonstrate that the tracking of free-roaming animal movements could be a useful method to interrupt the *E. granulosus* lifecycle and to reduce the spread of the disease.

Keywords. Echinococcosis, canids, home range, geospatial data, GPS

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References

Deplazes, P., Rinaldi, L., Rojas, C. A., Torgerson, P. R., Harandi, M. F., Romig, T., Antolova, D., Schurer, J.M., Lahmar, S., Cringoli, G., Magambo, J., Thompson, R.C., Jenkins, E.J., 2017. Global distribution of alveolar and cystic echinococcosis. Adv Parasitol., 95, 315-493. doi: https://doi.org/10.1016/bs.apar.2016.11.001

Kachani, M. & Heath, D., 2014. Dog population management for the control of human echinococcosis. Acta tropica, 139, 99-108. doi: https://doi.org/10.1016/j.actatropica.2014.05.011

Community-based precision mapping of Schistosomiasis: the experience of Rwanda

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Schistosomiasis is a neglected tropical disease transmitted by skin penetration of a cercaria when a person has contact with infested water. The disease is very focalized around areas surrounding water bodies. WHO set the elimination of schistosomiasis as a public health problem in all 78 endemic countries by 2030. Without accurate data from effective mapping design, the reach of this elimination target would be a fantasy. Rwanda is committed to eliminating schistosomiasis by 2024 which put unprecedented responsibility of using all available innovative tools to reach and demonstrate the achievement of this target. We conducted a nationwide community-based precision mapping survey with an innovative sampling design using spatial overlay function and spatial multicriteria analysis to locate all lower administrative areas (about 15000 “villages” in Rwanda), to which we appraised schistosomiasis risk level based on ecological and epidemiological factors favoring schistosomiasis transmission alongside epidemiological data. The selection of community mapping units to survey was based on high-risk level obtained after spatially explicit risk ranking. The selected areas represented villages sharing the same ecological and exposure context. In addition to the innovative design presented here, we demonstrated that potential barriers to the community-based mapping surveys are not unclimbable hills: inclusion of all age groups in the national community-based survey; persuasion of adults to provide stool sample among others were achieved. Our mapping process is comprehensive, practical, innovative and simple. It can be replicated and adapted elsewhere to produce optimal results. Meticulous planning, use of GIS technology, use of ecological and epidemiological information, and involving all relevant stakeholders including local stakeholders who have local knowledge is essential for this innovative mapping design.

Keywords: community-based, precision mapping, ecological and epidemiological factors, schistosomiasis, Rwanda

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A Marginalized Zero-Inflated Spatially Varying Coefficient Model for Disease Modeling

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Disease models are important for in public health emergency response and intervention. For rare diseases or sporadic epidemic diseases, the occurrences of zero observations within area references are common. Zero-inflated Poisson (ZIP) models have been developed to accommodate the excess zeros. We previously developed a zero-inflated Poisson spatially varying coefficient (ZIPSVC) model to account for the varying exposure effects. But there are inferential and interpretation challenges relating to modeling the exposure effects. The latent class interpretation that corresponds to the susceptible sub-population is often wrongly inferred to the sampled population. In this study, we propose a marginalized

ZIPSVC (MZIPSVC) model to address the following: (1) to estimate the overall marginal log-incidence density ratio of the sampled population, (2) to determine the spatially varying log-incidence density ratios of the sampled population, and (3) to estimate the spatially varying exposure effects on the sampled population. We tested the MZIPSVC model via a simulation study and compare it with the ZIPSVC model. We found that the MZIPSVC model consistently recovers the true parameters under the simulations. We illustrate the method by making inferences on the spatial distribution of district-level cholera incidences in Ghana. Unlike the ZIPSVC model, the MZIPSVC model allows straightforward inference of the exposure effects on the sampled population in a similar sense expected from Poisson regression. We conclude that (1) the MZIPSVC and MZIPSVC models have different exposure effects estimates as are their interpretations, (2) the choice of either MZIPSVC or ZIPSVC should be guided by how one intends to infer the estimated exposure parameters.

Water hyacinths: Use them or lose them? A holistic approach to a multi-faceted problem

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Lakes in tropical regions around the world suffer from the infestation of water hyacinth. Its proliferation is attributable to the influx of nutrient-rich waters, as rivers feeding the lakes are polluted with wastewater and run-off of fertilizer and manure from surrounding agricultural fields and husbandry within the catchment. The weed clogs waterways and intakes and affects aquatic life, water availability, transportation, fishing, irrigation, and tourism. Water hyacinth infestation has implications for human health, as it may facilitate the spread of water-related diseases. While water hyacinth may pose health risks, they have the potential to benefit human livelihoods when exploited for wastewater treatment, as fertilizer, for biofuel production or, when made into handicrafts, as a source of income.

A sustainable solution to these issues tackles both water quality deterioration and water hyacinth infestation, and "uses" water hyacinth instead of only attempting to "lose" them. We present a research project that identifies such solutions, applicable and appropriate within the local and cultural context of our study region, Lake Chivero, the main source of drinking water to Harare. The project consists of three main pillars: (1) performing systematic studies of causes and effects of water hyacinth spread based on satellite and empirical data; (2) scientifically investigating water hyacinth exploitation methods, and (3) engaging with stakeholders to co-develop strategies to address the challenges of water quality and water hyacinth. The project's impacts will be a more healthy and resilient lake ecosystem, improved wellbeing of people depending on the lake, and more resilient communities at Lake Chivero and other lakes in Sub-Saharan Africa. It will thereby contribute to the achievement of the United Nations Sustainable Development Goals (SDG) related to health (SDG 3), drinking water (SDG 6), and sustainable communities (SDG 11). Moreover, the project is in line with the South African National Development Plan 2030 and the African Union Agenda 2063.

Spread of the first varroa mite (*Varroa destructor*) incursion in Australia and the role of landscape

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Background. In June 2022, an exotic pest of the European honey bee (*Apis mellifera*), the varroa mite (*Varroa destructor*), was detected in surveillance hives at the Port of Newcastle, New South Wales (NSW), Australia. Despite a global distribution, previously Australia had remained the only populated continent free of the varroa mite. It was estimated that the establishment of varroa mite in Australia could lead to more than $70 million in losses each year due to greatly reduced pollination services. Following the incursion, a control and eradication campaign was conducted. However, by September 2023, the pest had been declared endemic. Worldwide, there are very few studies on the spread of varroa mite. Given the novel nature of this incursion in a previously free population, an outbreak investigation was conducted to understand how varroa mite spread across the landscape during its initial incursion phase in NSW, Australia.

Objective. To describe the spread of varroa mite in European honey bee hives in NSW, Australia, and the land use characteristics that were correlated with this novel spread.

Method. We sourced publicly-available varroa mite outbreak reports from the NSW Department of Primary Industries for the period 22nd June 2022 to 19th December 2022 to determine if urbanisation, land use and distance from incursion site were correlated with when varroa mite infestations occurred in European honey bee colonies. The outcome investigated was epidemic day i.e. the day each premises was infected, relative to the first premises (22nd June 2022; day 1). The study population consisted of 107 premises which were declared varroa-infested by the NSW Department of Primary Industries.

Results. During the 181-day study period, the median epidemic day was day 37 and a bimodal distribution was observed in the epidemic curve, reflective of an intermittent source pattern of spread. We found that premises were infected with varroa mite earlier (day 25) in urban areas compared to rural areas (day 37.5; $P<0.001$). No significant correlation was found between the distance to the site of incursion and when premises were infected. Infected premises located in areas without cropping, forests and irrigation occurred earlier in the outbreak compared to areas with

cropping, forests and irrigation (P≤0.001). No association was found with horticultural land use (P>0.05). The primary cluster of infested premises (13 observed premises, 1.82 expected) occurred during the first week of the outbreak, at the site of the initial incursion.

Conclusions. The findings from this investigation suggest that varroa mite spread quickly during its first incursion in Australia in what appeared to be an urban, human-mediated pattern. It suggests that the control measures were either ineffective or were applied too late during the initial phases of spread. Non-commercial honey operations might have contributed to this failure to control the incursion.

Mapping the space, time & scale of disease. A decision tree for selecting the appropriate technique for mapping disease data

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Background. Mapping infectious diseases can be challenging, especially due to difficulties in integrating both spatial and temporal elements within a map. Disease outbreaks may occur over short or long periods of time and the affected area can vary from neighborhoods to the global level. The recent COVID-19 pandemic underscored the shortcomings in traditional disease mapping, resulting in many suboptimal maps due to compromises made on either the spatial scale or the temporal scale. Despite the nearly endless possibilities in (interactive) mapping tools, research has shown that contemporary disease maps are often difficult to interpret. Understanding of the dynamics of spatial and temporal scales are crucial for effective disease mapping.

Objective. This study aims to provide an overview and decision tree for selecting appropriate mapping techniques suitable for various disease types, spatial scales and temporal scales. In this study, infectious diseases, chronic diseases and exposure related diseases will be considered. On the spatial scale, the two main relevant factors are the grain (resolution of the mapped area) and extent of the total study area. On the temporal scale, the focus will be on the selection of intervals between time points, as well as the total time extent of the map.

Methods. A decision-tree will be developed that will guide the user in the selection of mapping techniques based on the disease type, spatial scale and temporal scale. By combining review articles on disease mapping with examples of historical and contemporary disease maps, a comprehensive overview of effective strategies for disease mapping will be presented.

Results. The application of the decision tree on disease outbreaks of different types and scales results in both a more standardized mapping approach, as well as clearer disease maps compared to traditional mapping practices. Various examples of disease maps that are guided by the decision tree will be provided, which will demonstrate the advantages over traditional mapping approaches.

Conclusions. Every disease outbreak is unique, which highlights the importance of advancing beyond traditional approaches and emphasizes the need for tailor made maps for every combination of disease type, spatial scale and temporal scale. This research presents an overview of the relevant aspects to consider when making a disease map, together with a practical decision tree that operationalizes these different aspects for different disease contexts. The consideration of the adequate spatial and temporal scale can contribute to a more streamlined and effective process of disease mapping. The decision tree presented in this study is a valuable tool for researchers and policy makers and can aid in creating understandable disease maps.

Augmented Intelligence for Sustainable Water and Health

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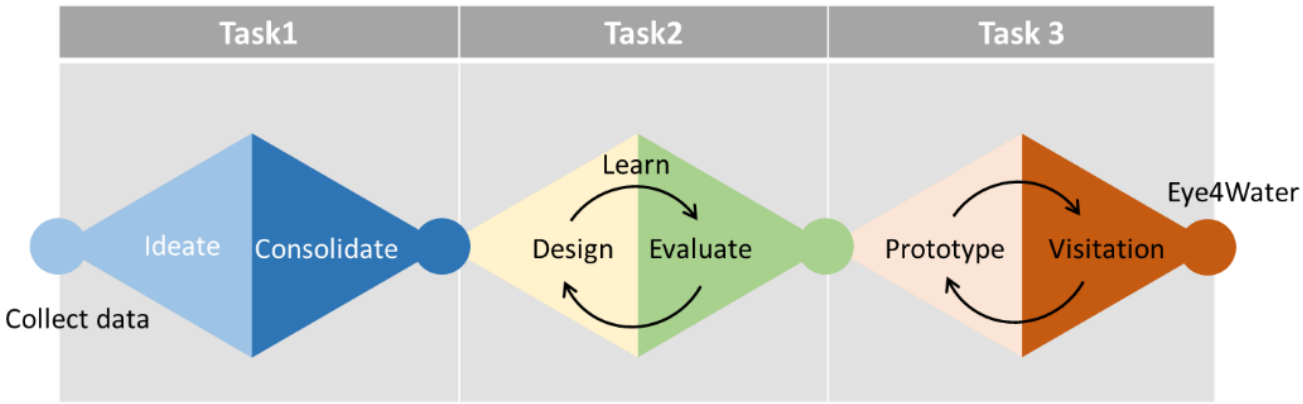
Background. Sustainable use of water resources is a great challenge, simply because of the many factors and actors that are contributing to the way water is governed, the practices that threaten water resources, different pollutants and their effect on human and ecosystem health. Understanding the processes that impact water quality and quantity is just the beginning. It's crucial to connect these processes with the socioeconomic aspects of stakeholders and policy-making and consider their impact on the well-being of the human and ecosystem. Therefore, sustainable use of water resources represents a wicked problem; its comprehension necessitates deep insights into biophysical processes and their interplay with human health and socioeconomic practices. The main ingredients to achieving sustainability of water resources and improving the quality of policy and decision-making are consistent and harmonized observation, modelling, community health and engagement in space and time. This type of education that combines these four competencies (observation, modelling, community health and practice, and water governance) is lacking. Nonetheless, we foresee an increasing demand for professionals that combine these knowledge domains, on the one hand, due to the increasing impact of climate change on communities and, on the other hand, due to the dynamically changing societies with a steady increase in digitalization in policymaking.

Objective. The University of Twente, together with partners from Italy (Padua University), Slovenia (Ljubljana University), and Sweden (Uppsala University), aims to develop a new master's program that integrates these knowledge areas. The ambition is to build competence to face climate change, with a specific focus on developing a new class of water scholars with the capability of providing efficient adaptation strategies, optimizing thereby the sustainable use of water resources whilst improving the well-being of humans and the environment.

Method. We employ the cyclic process approach of Bishop- Clark and Dietz-Uhler (2012). The approach iterates on five main phases as shown in Figure 1:

1. Collect data, alumni and job-market surveys, administrative, quality check and accreditation rules data will be collected on higher education in the four contributing countries. The surveys will be designed as cross-sectorial based on Ross (2005) and de Leeuw et al., (2008) methods.
2. Analyse the data: analyse the collected data to establish the design requirements of the programme. Using the European Statistics Code of Practice (COM 2017) and the statistical measures of Presser et al., (2004).
3. Design the programme using the triple diamond model (Design Council 2007) to identify and realize the best design.
4. Prototype: Realize the best design make use of available courses and develop new ones if necessary. 5- Test and trial accredit the prototype of the programme and carry out the trial pre-accreditation process through visitation, i.e., peer-evaluation and self-reflection reports (Fry et al., 2009). The results of the visitation will be used to refine the design of the programme and apply for accreditation.

Figure 1. the triple design method that wil be adopted to design and create the Eye4Water programme



Results. The concept behind Eye4Water has received funding from the European Commission, and this conference marks the commencement of its implementation. Nevertheless, the consortium has diligently conducted collaborative co-creation sessions to strengthen partnerships, culminating in an initial design that maximizes benefits for all participating universities. We show the initial design of Eye4Water in Figure 2.

Figure 2: initial design of Eye4water resulting from the co-creation sessions. MGEO (MSc in Geoinformation Science and Earth Observation, NL); WGRE (MSc in Water and Geologic Risk Engineering, IT), ITLS (MSc in Implementation, Transformative Learning and Sustainability, SW); WSEE (MSc in Water Science and Environmental Engineering, SL).

Conclusions. Eye4Water is a unique master's programme in the EU that concerns equipping the next generation of water scholars with the complete chain of value creation, from collecting data to formulating science- informed policy and decisions. The Eye4Water bridges the current gap in higher education and prepares the next generation of scholars to tackle the most challenging and wicked problem of this century, securing

quality and safe water for all. Eye4Water has a thematic focus on the water-health nexus and intertwines geospatial science, data science socioeconomic aspects of sustainability, community practices and the art of decision and policy-making.

The power of interactive maps for communicating spatio-temporal data to health professionals

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Introduction. Interactive maps have become an important part of everyday life, from general purpose navigation offers like Google Maps and Openstreetmap, to specialized tools communicating detailed information wherever a static figure does not suffice. When it comes to communicating health-related facts and figures, however, the technology has not yet been utilized to its full potential in practice. For many diseases and conditions, relative risks depend not only on personal factors like age or occupation but vary in space and time. Knowing where and when disease risks are elevated can inform the public, support physicians in diagnosis and treatment, and guide authorities and decision makers in building strategies to alleviate those risks. Using the Twente-Achterhoek region, the Netherlands, as a cases study, we demonstrate how an integrated system of interactive maps and dynamic figures can greatly enhance the accessibility and interpretation of complex spatio-temporal health data.

Methods. We used Shiny, an R package for creating interactive web applications, to build two technology demonstrators:
1) The European Notifiable Diseases Interactive Geovisualization (ENDIG): an interactive tool to visualize and explore the implementation status of governmental disease surveillance systems across the European Union. This system uses data that is publicly available but practically inaccessible to the public due to lack of visualization.
2) The Zoonotic Infection Risk in Twente-Achterhoek (ZIRTA) Map: a prototype information system for vector-borne disease risk in the Dutch Twente-Achterhoek region, aimed at physicians, public health professionals, and the general public. This tool uses disease surveillance data and environmental covariates to evaluate spatial variation and temporal changes in disease transmission dynamics.

Results. Our demonstrator applications show that interactive maps have great potential for making complicated, multi-dimensional information on health-related topics easily accessible to physicians, decision makers, and the general public. Especially where spatial and temporal aspects come into play simultaneously, an interactive approach can be vastly superior to any single figure.

Conclusion. As recent advances in cloud computing and AI technology open up never before seen possibilities in processing and analysing ever increasing amounts of data, visualization techniques need to evolve as well. Where traditional illustration techniques would require either considerable compression of information or numerous subfigures, interactive approaches can reduce complexity while still retaining a sufficient level of detail. In increasingly data-heavy societies, translational systems like the ones proposed here will be a crucial component of evidence-based medicine with the additional benefit of increasing awareness in the public as well as the professional domain.

Utilizing Geospatial Methods to Drive Health Service Delivery in the Era of Climate Change

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Background. Climate change is set to exacerbate certain drivers of acute crises, such as natural hazard-induced disasters, the emergence of novel diseases, re- emerging of “old diseases”, and forced migration of vulnerable populations. In such contexts, evidence-informed decision-making is essential to deliver targeted health services. However, necessary evidence is often lacking during acute crises. Geospatial methodologies can support the body of evidence required to drive optimal health service delivery, including geostatistical risk modeling, geographical access analysis, and multicriteria spatial risk assessments.

Objective. The primary objective of this paper is to demonstrate how geospatial methodologies can support health service delivery in the context of acute crises driven by climate change and variability. It will also discuss challenges to improving the quality and utility of geospatial methods and actions that policy makers, practitioners and researchers can take to improve them.

Method. We conducted a scoping review into geospatial methodologies used in acute crises and will present the results including a set of case studies conducted by the authors. Case studies are discussed in relation to the phases of disaster management (figure 1): preparedness (including anticipatory action), response, recovery, and mitigation.

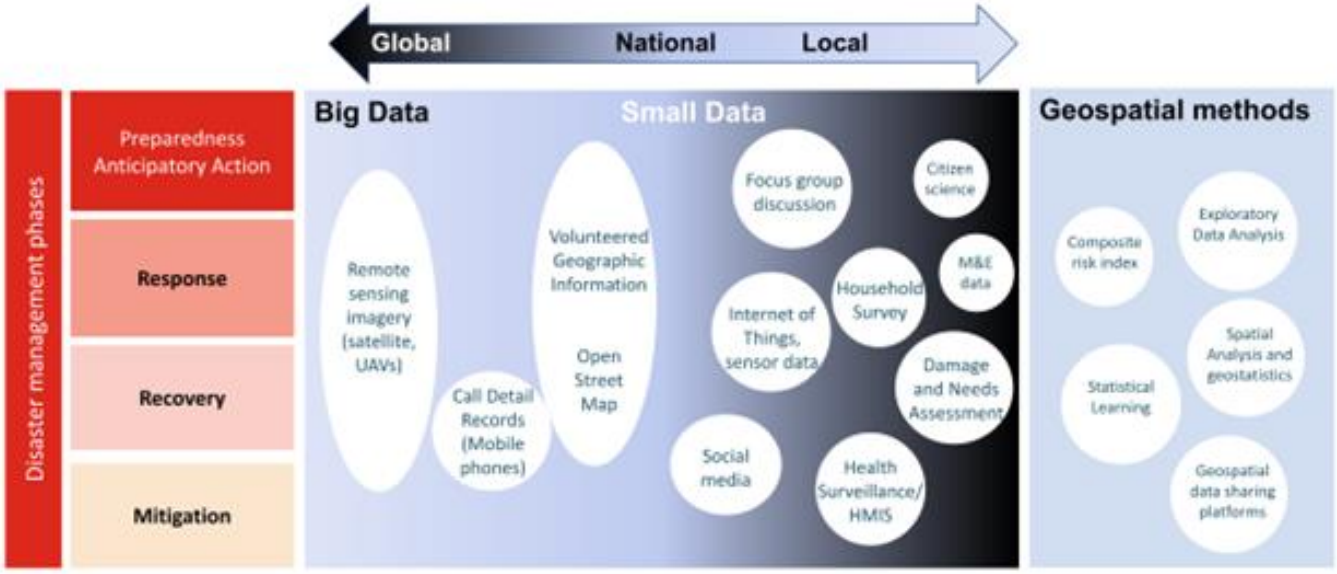

Figure 1 The use of geospatial methods, and big and small data across the four disaster management phases. M&E= monitoring & evaluation; HMIS= Health Management Information System

Results.

- Preparedness: A geospatial drinking water security index was developed for Sudan, assessing water security at various subnational levels. It identified high-risk maternity facilities with reduced (and risk for reduced) water access. This information supports stakeholders in improving water security and healthcare facility resilience to environmental changes.
- Anticipatory action: geospatial risk assessments and so-called trigger models for extreme weather events were developed that predict when a threshold is expected to be exceeded, along with a predetermined probability and magnitude. A transferable epidemic risk index and a forecasting model using hydrological data for dengue was constructed and validated in the Philippines. Additionally a malaria prediction model for Ethiopia and a cholera composite risk index for Cameroon were developed using open data in modeling approaches that work in data-scarce environments.
- Response & recovery: Geospatial modeling assessed loss of geographical accessibility in Mozambique's healthcare system post-cyclone. Analyzing travel times to health facilities revealed decreased accessibility due to damaged transport networks, floods, and non-functional facilities. This approach informs resource allocation and aids effective decision-making for disaster response and healthcare recovery.
- Recovery: geospatial methods (MATCH) were used on real time surveillance, health systems and population data to geo-optimize care services for infectious disease. In Lesotho, spatial variations and gaps in the pathway of tuberculosis care were studied, local health care needs were identified, and interventions were strategized to find missing people with TB in a post-COVID setting. This method can be used to define critical infrastructure and health service resilience during disasters.

While geospatial methodologies are already used, challenges remain to improve their quality and utility. These include timely availability of geospatial data in disaster settings, data protection for the most vulnerable, development of standardized data formats, pre-disaster data availability for preparedness, gaps in health incidence data, underreporting of cases and lack of spatial and temporal coverage and granularity.

Fortunately, a host of remedial actions are available to policy makers and researchers: a cross-sectoral preparedness plan describing information needs and flows across domains (health, emergency & response/civil protection, environment, risk communication), use of vocabulary fitting different audiences, establishment of data sharing agreements, digital capacity building of actors from national to local level, and digital transformation of surveillance processes.

Conclusions. Existing and novel geospatial methodologies can bridge specific evidence gaps found throughout phases of disaster management. Development of these methodologies may provide opportunities for more evidence-informed decision making in response to acute epidemiological crises in the era of climate change.

Remote sensing as an exposomic measurement tool for pulmonary diseases management

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No abstract details.

POSTERS PRESENTATIONS

Flexible scan statistics for optimized COVID-19 surveillance in Ghana

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Background. The risk of COVID-19 new variant that can cause new surges in cases and deaths remains eminent. WHO recommends the integration of COVID-19 surveillance with other respiratory diseases and the institution of geographically representative genomic surveillance. Ghana which has recorded over 130,000 COVID-19 cases and 1400 deaths so far through its routine surveillance with limited spatial analysis. The successful implementation of the new strategy requires knowledge of areas with elevated risk. The study employed cluster analysis to uncover the spatial patterns of COVID-19 incidence and Case Fatality Rate and its related factors at four pandemic peaks.

Methods. We obtained the daily count of COVID-19 cases and deaths reported in Ghana from 12 March 2020 to 28 February 2022. A flexible scan statistics was used to examine the cluster of COVID-19 incidence and Case Fatality Rate(CFR) at four pandemic waves. Our study further accounted for the distance to the epicenter and the proportion of the urban population by fitting a General Lineal Model(Poisson).

Results. The flexible scan statistics identified significant spatial clusters of COVID-19 incidence (56) and CFR (26) at all four waves of the pandemic. Most Likely Clusters (MLC) of COVID-19 incidence persisted in the districts located southeastern while CFR occurred in the central and northeastern parts of Ghana. These districts could potentially serve as a site for sentinel or genomic surveillance. A spatial relationship was identified between urban population, distance to epicenter and COVID-19 incidence. An increase in distance to epicenter and the urban population was found to increase CFR. A change in the locations of the district with an elevated risk of COVID-19 incidence and CFR was observed after accounting for the covariates.

Conclusion. COVID-19 incidence and CFR are spatially clustered and are affected by the proportion of the urban population and distance to the epicenter. Therefore, surveillance intervention should consider districts with elevated risk. Additionally, long-term control measures for COVID-19 and other contagious diseases should consider improving quality healthcare access and rural-urban migration.

Prioritizing the location of vaccination centers during a pandemic by bikes in the Netherlands

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Background. The Netherlands launched its vaccination campaign against COVID-19 in early 2021, aiming to achieve widespread immunization coverage. The overarching goal was to reach at least 85% of the total population, surpassing the 70% threshold recommended by the World Health Organization for herd immunity. Initially, large spaces like sports halls and public parking areas were used as fixed vaccination centers, but the strategy evolved to include mobile vaccination buses and pop-up centers, especially in regions with lower vaccine uptake. This adaptable "Fine-meshed" strategy also involved closing underutilized fixed centers as the campaign progressed, emphasizing the vital need for strategically positioning vaccination centers in response to the evolving pandemic situation.

Objective. The aim of this study is to determine the optimal number and locations for COVID-19 vaccination centers in all GGD regions, with a focus on ensuring accessibility by bicycle. This study aims to achieve three population coverage scenarios (50%, 70 %, and 85%) to enhance the national Dutch vaccination strategy.

Method. Our methodology for determining the optimal locations involved using the location set covering problem (LSCP) model to ensure access for the whole population. In addition, we prioritized the most accessible locations according to their demand volume for each

coverage scenario in all GGD regions. Using publicly available data, we conducted our study by geocoding the addresses of all COVID-19 vaccination centers obtained from the regional public health service (GGD) websites. We also utilized transportation network data and potential candidate locations data from OpenStreetMap. We used high-resolution population data from Statistics Netherlands (CBS) to find the demand for the selected vaccination locations.

Results. Our analysis showed that the selected locations for achieving the coverage scenarios were primarily concentrated in densely populated regions previously neglected by the existing vaccination strategy. The number of the selected locations was not evenly distributed across GGD regions, and the number of patients that could be reached varied significantly depending on the population density and distribution. Our detailed analysis revealed that several regions required significantly more centers than others to achieve the same population coverage, while certain regions achieved the targeted coverage with existing centers. We also found a significant difference in the number of people that the selected centers could serve, with some regions relying mainly on centers with low demand volume, while others primarily needed centers with higher demand volume.

Conclusions. Location models and Geographic Information Systems (GIS) can significantly impact decision-making when it comes to mass vaccination efforts. To increase COVID-19 vaccination strategies effectiveness, a nuanced distribution approach considering accessibility and demand is crucial. The variations in demand per location among regions highlight the need for distribution decisions tailored to each region's needs. In addition, low-demand locations should be a part of any mass vaccination that must be conducted in a short time.

Domestic wastewater ABM for health: Linking spatiotemporal dynamics, population, and wastewater-based epidemiology

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Problem. Monitoring diseases like COVID-19 via wastewater ribonucleic acid (RNA) samples has gained much attention over the past years. Worldwide, many monitoring networks have been set up to detect and study diseases through wastewater- based epidemiology (WBE), where it is known that diseases, such as COVID-19, can be detected from the stool. However, spatiotemporal WBE modeling for disease predictions faces complex issues that hold improving prediction accuracies. Among the issues is that RNA samples are affected by the dilution of water appliances and their chemicals (Torabi et al., 2023).

Objective. We present a spatiotemporal Agent-based model (ABM) of wastewater dynamic, where: i) The ABM provides population data with water appliances events that can be analyzed with RNA samples to improve the insights from WBE, and ii) The ABM provides information to target stool and avoid chemical dilution from water appliances events to increase RNA sampling significance and improve modeling predictions.

Methodology. The method applies spatial microsimulation (Lovelace and Dumont, 2018) to generate a synthetic population imported into the ABM. The ABM model is designed and developed based on a discrete-event approach to explicitly denote time in each simulated event of the representation of domestic water (DW) dynamics. The ABM has three submodels representing the DW dynamics linking population characteristics, DW events, and DW loads that can be tracked across space and time.

Results. The ABM results allow the spatial and temporal tracking of DW events linked to individual inhabitants. WBE can benefit from implementing smarted RNA sampling where stool dilution by other water appliance events is avoided.

Co-circulation of Mosquito-borne Diseases in Colombia: A bivariate Geostatistical Approach

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Co-circulation of diseases poses critical public health challenges by indicating population cross-exposure and linked transmission dynamics. While co- occurrence is common, spatial analysis often overlooks inter-disease interactions by focusing on individual conditions. This study investigates spatial co- circulation of Zika, Dengue, and Chikungunya in Colombia's Andean region,an area highly affected by mosquito-borne diseases. Using Poisson cokriging, a method tailored for count data that accounts for population distributions and integrates auxiliary covariates, we modeled individual and joint disease risks. Results demonstrate Poisson cokriging effectively mitigates variable population densities for refined risk estimation. Incorporating co-infections further im- proved individual risk characterization and hotspot identification. High-risk municipalities exhibited substantial co-circulation

coupled with inadequate water, hygiene, and crowded living conditions. Outcomes improve understanding of disease interactions and synergies while offering insights for tailored interventions. This novel approach and findings on tri-disease co-circulation contribute key geographic perspectives on emerging disease syndemics.

Keywords. multivariate geostatistics; mosquito-borne diseases; Poisson cokriging; disease risk.

Distribution of gastrointestinal nematodes and anthelmintic treatments in sheep farms in the Campania region of southern Italy

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Background. Gastrointestinal nematode (GIN) infection endangers ruminant health and welfare and is commonly associated with economic losses mostly through subclinical diseases impairing weight gain and milk yields (Charlier et al., PrevVetMed, 2020). The worldwide increased difficulty to combat GIN infection in ruminants, due to progressing anthelmintic resistance (AR), requires innovative methods to rapidly detect outbreaks of AR. In recent years, the onset of the first cases of AR in sheep farms in Campania region (southern Italy) has been reported (Bosco et al., ParasitVectors, 2020) compared to very high anthelmintic efficacy recorded up to a decade ago (Rinaldi et al., Vet Parasitol, 2014).

Objective. This study provides a scenario of the current distribution of GINs in some sheep farms selected based on the number of anthelmintic treatments recorded in recent years.

Method. The study population is represented by sheep farms in Campania region present in the National Pharmacosurveillance Information System which collects all veterinary prescriptions (*Ricetta Elettronica Veterinaria* - REV). The information present in the National Database (*Banca Dati Nazionale* - BDN) related to production orientation and number of animals has been added to the REV sheep farms. The target population consists of sheep farms that have had veterinary prescriptions for anthelmintics (Macrocyclic lactones - MLs and Benzimidazoles - BZs) in the period 2019-2020 with a meat, milk, and mixed production orientation and with a number of animals present on the farm greater than 50. The design of the research study assumes a minimum of farms to be tested equal to 35; considering a confidence interval of 95% the minimum calculated sample size is equal to 20 farms (RStudio software - version: 2022.12.0 Build 353). In each farm, individual faecal samples were collected from 15 adult and 5 young animals. The samples were analysed using the FLOTAC technique (Cringoli et al., NatProtoc, 2010) for the characterization of the GIN infection. The results of this investigation were represented on a map using QGIS software (QGIS software Version 3.22.7-Białowieża).

Results and conclusions. In the reference period (2019-2020), 260 sheep farms present in the REV received prescriptions for anthelmintic drugs with an average of 2.0 prescriptions (min 1-max 7). While, 20 selected sheep farms had a REV mean number of 3.2 for the LMs and 2.7 for the BZs. The parasitological results of 20 farms examined showed different values of eggs per gram (EPG) of faeces which were grouped into 4 ranges: [10-50 EPG], [51-200 EPG], [201-400 EPG], [>400 EPG].

The preliminary data of the research show a widespread presence of GIN with high EPG values despite the frequent use of anthelmintics. The mapping of these farms (with high EPG values despite frequent anthelmintic treatments) may indicate an area at risk for anthelminthic resistance where it can be investigated with field trials. For this reason, the second part of the research project will concern the administration of the appropriate doses of anthelmintic and the verification of anthelmintic efficacy.

Research project. IZS ME 09/20 RC «Strongilosi gastrointestinali di bovini e ovini: valutazione dell'antielmintico-resistenza in allevamenti della regione Campania» Ministero della Salute.

Presenting author. Chen Song

Flood disasters affect different aspects of elderly people's social and mental health. To characterize the status of social health and mental health of elderly adults and to discuss vulnerability during floods, we conducted a systematic review of the existing peer-reviewed literature on the topic worldwide. We identified eleven papers to be included in the review. We extracted and analyzed the data based on a model of flood stress in elderly adults modified by the Disaster Pressure and Release (PAR) model, as well as social health and mental health content. Included studies considered the implications of floods on the social and mental health of elderly adults from different countries in North America, Asia, Europe, and Oceania in the last century and this century.The results indicate that floods in these countries have affected the social health and mental health of elderly people. In social health aspects, flood effects on isolation, low network support, and lack of information are more common to see; whereas lack of sense of place and belonging is lessprevalent. In social health isolation, low network support, and lack of information are more common, whereas lack of sense of place and belonging is less prevalent. In mental health aspects,elderly people reported depression;

anxiety, worries, and PTSD are more common after flood, while sleep problems are found less frequently. The current studies' number and location are limited and should be extended to more areas.
