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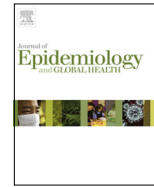
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An assessment of the occupational and environmental health needs in seven Southeastern European and West-Central Asian countries

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Abstract Eastern European and Central Asian countries are undergoing rapid socioeconomic and political reforms. Many old industrial facilities are either abandoned, or use outdated technologies that severely impact the environment. Emerging industries have less regulation than in developed countries and environmental and occupational problems seem to be increasing. Under a US National Institutes of Health pilot grant, we developed an interdisciplinary One Health research network in Southeastern Europe and West-Central Asia to identify environmental and occupational problems. From 2012 to 2014, this GeoHealth Hub engaged 11 academic centers and 16 public health institutions in eight different countries: Albania, Armenia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Romania, and the United States with a goal of strengthening environmental and occupational research and training capacities. Employing face-to-face interviews and large group meetings, we conducted an evidenced-based needs and opportunities assessment focused on aquatic health, food safety, and zoonotic diseases. Comprehensive reviews of the

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published literature yielded priority research areas for each of the seven GeoHealth Hub countries including heavy metal and pesticide contamination, tick-borne diseases, rabies, brucellosis, and inadequate public health surveillance.

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1. Introduction

Eastern European and Central Asian countries are undergoing rapid socioeconomic and political changes which are impacting their health system organizational structure [1,2]. Emerging industries within these countries, such as chemical production, car manufacturing, and agricultural activities have less safety regulations compared to analogous industries in developed countries, and by some metrics, environmental and occupational problems are increasing [3]. Considerable evidence exists that correlates health status with socioeconomic status in these countries and that lower income countries experience further health impacts [4,5]. Other public health issues impacting these countries involve outbreaks of enteric pathogens due to contaminated products, antimicrobial resistant organisms linked to animal production, and zoonotic disease outbreaks [6].

Thus, many of today's environmental and occupational public health problems are exceedingly complex and influenced by global economics. Understanding and mitigating these problems requires a partnership of diverse professional disciplines and industry partners.

1.1. GeoHealth Hub formation

In an effort to assess these complex, emerging problems impacting Southeastern European and West Central Asian countries, collaborators from the University of Florida, USA and Babeş-Bolyai University (BBU), Romania, established the GeoHealth Hub for Eastern Europe and West Central Asia. The GeoHealth Hub was established with the help of a grant from the US National Institutes of Health's Fogarty International Center. The Fogarty International Center aims to address global occupational and environmental health issues abroad by awarding research grants to paired US and low- or middle-income country-based institutions to develop regional research hubs. The overarching goals stemming from the development of regional hubs include developing "collaborative research, data management, training, curriculum and outreach material development, and policy support around high priority

local, national, and regional environmental and occupational health threats" [7]. As such, in November 2012, the GeoHealth Hub initiated meetings to develop and solidify plans with preexisting collaborators from the following seven low- and middle-income countries (LMICs): Albania, Armenia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, and Romania. These countries would serve as the target countries for the GeoHealth Hub and were chosen from previous collaborating partner institutions.

Upon formation, the GeoHealth Hub decided to embrace a One Health approach in their research methodologies. This approach relies on the collaboration and expertise of multi-disciplinary professionals to solve complex health problems stemming from interactions between human, animal, and environmental factors [8]. Collaborators consisted of varied professionals from public health, veterinary health, and environmental health backgrounds working in 27 institutions from eight countries (Table 1).

1.1.1. GeoHealth Hub objectives

The short-term goals of these collaborations were to assess three key areas affecting GeoHealth Hub countries that fall under the umbrella of environmental and occupational health. These key areas included: (1) aquatic health, (2) food safety, and (3) zoonotic diseases. Long-term objectives for the GeoHealth Hub include strengthening institutional capacity for environmental and occupational health research and training, employing a One Health approach to identify research needs, and then successfully designing research interventions for the target countries.

At a series of November 2012 small group meetings with a goal to identify the issues related to aquatic health, food safety, and zoonotic diseases in the target countries, collaborators agreed to conduct a literature review and a prioritized, health needs assessment (HNA) for each country. Participants (Table 2) convened in Cluj-Napoca, Romania in June 2013 to share and discuss findings from each country. This report details the findings from the literature review and HNA performed for the seven target countries.

Table 1 Partner countries and their respective partnering institutions in the GeoHealth Hub.**United States**

- University of Florida (in late 2014 the grant moved with Dr. Gray to Duke University)

Romania

- Babeş-Bolyai University Cluj-Napoca
- University of Agriculture and Veterinary Medicine
- University of Medicine and Pharmacy
- Cluj County Public Health Department
- Alba County Public Health Department
- Institute of Public Health Romania
- Tulcea County Sanitary Veterinary and Food Safety Department

Kazakhstan

- Kazakh National Medical University named after S.D. Asfendiyarov
- National Center of Occupational Hygiene and Occupational Diseases, Karaganda city
- Scientific and Practical Center of Sanitary and Epidemiologic Examination and Monitoring, Almaty city

Kyrgyzstan

- International University of Kyrgyzstan
- Kyrgyz-Russian Slavic University

Georgia

- University of Georgia
- National Center for Disease Control and Public Health
- Tbilisi State University
- WHO Georgia office
- N. Makhviladze, Ecology and Occupational Medicine Institute

Armenia

- Yerevan State Medical University
- Yerevan State University
- Armenian Association of Preventive Medicine
- Ministry of Health
- Ministry of Agriculture
- State Hygienic and Epidemiologic Inspectorate

Moldova

- State Medical and Pharmaceutical University

Albania

- Albanian Institute of Public Health and Faculty of Public Health
- National Institute of Public Health

2. Methods

Our health assessment approach consisted of two components to identify the main aquatic health, zoonotic diseases and food safety problems in each of the partnering seven LMICs. The first component involved a published literature review and the second component involved creating a HNA via expert teams from each country that synthesized and prioritized public and non-public data from each LMIC country. Many of these documents were written in local languages, which often included Russian.

2.1. Literature review methods

In order to identify relevant contributions in the fields of aquatic health, zoonotic diseases and food safety in the selected countries, partners at BBU in Romania searched for English-language papers in PubMed and ScienceDirect databases. Additionally, Google Scholar was used to find technical reports,

conference proceedings, position papers, periodicals, and books.

The literature review used key words combined with the target country names as a mechanism of inclusion for the literature review. The selected key words were *water standards, water resources monitoring, water-borne infectious diseases, water-borne outbreaks, wastewater management, food safety, food-borne infectious diseases, food-borne outbreaks, zoonoses, and zoonotic diseases*. The list of keywords was established after analyzing the Environmental Performance Reviews for each of the countries involved in the study, where problematic issues in the fields of aquatic health, zoonotic diseases, and food safety were highlighted. These keywords could be present in any component of the publication. Only publications written in English were included in the literature review. However, literature published in other languages such as Russian, Romanian, Albanian, Georgian, and Armenian were identified and examined by national experts and included in the health needs

Table 2 List of GeoHealth Hub participants from the June 2013 GeoHealth Hub meetings in Cluj-Napoca, Romania.

Participants	Country	Institutional Affiliation/University
Artashes Tadevosyan	Armenia	Yerevan State Medical University
Sergey Karapetyan	Armenia	National Centre of Disease Control, Yerevan State Medical University
Chirlici Alexei	Moldova	State University of Medicine and Pharmacy "Nicolae Testemitanu"
Friptuleac Grigore	Moldova	State University of Medicine and Pharmacy "Nicolae Testemitanu"
Ramaz Urushadze	Georgia	University of Georgia
Nino Giuashvili	Georgia	University of Georgia and Ministry of Health
Kenesh Dzhusupov	Kyrgyzstan	International School of Medicine
Katarbayev Adyl	Kazakhstan	Kazakh National Medical University
Enver Roshi	Albania	National Institute of Public Health
Gregory Gray	United States	University of Florida, USA
Tara Sabo-Attwood	United States	University of Florida, USA
Alexandru Coman	Romania	Babeş-Bolyai University, Center for Health Policy and Public Health
Elena Cionca	Romania	Babeş-Bolyai University, Center for Health Policy and Public Health
Emanuela Marton	Romania	Babeş-Bolyai University, Center for Health Policy and Public Health
Sorin Răpotean	Romania	University of Agricultural Sciences and Veterinary Medicine
Răzvan Cherecheş	Romania	Babeş-Bolyai University, Center for Health Policy and Public Health
Ioana Duşe	Romania	Babeş-Bolyai University, Center for Health Policy and Public Health
Maftai Daniel	Romania	Head of Animal Health Department of Tulcea Veterinary State Laboratory,
Moisescu Mihai	Romania	Cluj Public Health Authority

assessment phase. For inclusion in the review, there were no limitations with regard to the year of publication, publication type, or format. The exclusion criteria were related to a lack of specific data from the selected countries on the topics reflected by the keywords. Also, failure to identify the author, year of publication, publishing house and/or website led to exclusion from the review.

All of the documents identified were reviewed by two independent researchers following the same protocol for data collection. For each paper selected, the following information was obtained: title of paper, author(s), year of publication, setting, study objective as stated by authors, data source(s), problems identified, and solutions proposed, if presented.

2.2. Health needs assessment (HNA) toolkit and training

Before conducting the HNA, we constructed a HNA toolkit, which was adhered to by every participating country. The toolkit consisted of a template to provide a consistent methodological framework to be used by countries as a first step in developing their country's health profile with regards to aquatic health, food safety, and zoonotic diseases.

In order to collect the data for the HNA toolkit, each of the twelve participating academic centers was asked to identify professionals working in public health, human medicine, environmental health, and veterinary health to participate in a web-based, One Health introductory training. Through a half-day

training program, they were guided to perform an evidenced-based needs assessment survey for their country. The targeted data included national public health reports, public health surveillance data, health statistics, and expert evaluations. As part of the HNA, the country-specific teams were also asked to extract problem theme data from the non-public literature from their respective countries, such as internal reports or government documents, which were often in the country of origin's language.

2.3. HNA data analysis and ranking

Each institutional team was then asked to compile their data and data sources, and to rank the top five problems in each of the three categories (aquatic health, food safety, and zoonotic diseases) by citing, where possible, objective health indicator criteria such as disability-adjusted life years (DALYs), mortality rates, and premature birth rates associated with the problem. HNA data were then aggregated and prioritized by a 14-member committee during a second meeting of the project consortium, which took place in Romania during June 2013. Where possible, needs were prioritized by health indicators and estimates regarding the opportunity to perform interventions to reduce these public health deficits.

3. Results

3.1. Literature review results

The literature review identified 254 English-language articles that fulfilled inclusion criteria.

After scanning their abstracts and applying the exclusion criteria, 47 articles were relevant to the study purpose. Of these 47 articles, 33 specifically related to aquatic health, zoonotic diseases and foodborne illnesses (See [Supplemental Table S1](#) for extracted data from the 33 articles).

Much heterogeneity existed with regards to the volume of data gathered within each focus area between the target countries. For example, the literature review revealed a number of articles concerning aquatic health for Albania, Moldova, and Romania, and to a lesser extent for Armenia and Kazakhstan. On the other hand, no such English-language published reports regarding aquatic health were identified for Georgia. Data regarding zoonotic diseases were most prevalent for Albania and Kazakhstan, whereas little or no data were available for Armenia, Georgia, Moldova, and Romania. Food safety was the least covered field, as literature was only identified for Albania, Armenia, Moldova, and Romania.

3.2. Literature review and HNA results for aquatic health

Results examining aquatic health issues in the seven countries revealed varying levels of pollution, which included contamination from insecticide use, mining, industry, radiation by-products, and raw sewage related to a lack of water resource management. [Table 3](#) summarizes results from the HNA.

For Albania, the literature demonstrated that the main aquatic issues included organochlorine pesticide contamination, especially in fish from the Vlora Bay [\[9\]](#), evidence of domestic sewage discharge into waterways via cross-contamination of sewers through illegal connections [\[10,11\]](#), and excesses in heavy metals including arsenic levels in river sediment ranging from 10 to 68 mg/kg in sediments collected from 3 to 4 sites along the Mati, Ishmi, Shkumbini, and Semani rivers [\[12\]](#). The authors denoted two sampling sites along the Mati and Shkumbini rivers as “Markedly Polluted,” with arsenic levels falling between 25 and 100 mg/kg and the remaining sites as “Moderately Polluted,” with arsenic levels falling between 5 and 25 mg/kg [\[12\]](#).

Armenia experiences elevated mineralization levels in groundwater, especially in the Ararat Valley [\[13\]](#). The literature revealed an excess in molybdenum (above 10 µg/L) and arsenic levels (above 50 µg/L) when examining concentrations of heavy metals in a variety of water types. Armenia also lacks a permanent national water

management board and has an outdated legal framework; the literature suggests that these obstacles hinder cross-sectorial cooperation for clean and safe water in Armenia. Likewise, Georgia lacks a national strategy for integrated water resource management. Waterborne diseases [\[14\]](#), high loads of phosphates and nitrates in rivers, as well as copper (up to 5 mg/L in the Mashavera river) and cobalt (up to 0.06 mg/L in the Rioni river) contaminate Georgia’s water systems.

Kazakhstan has experienced water pollution due to many industrial processes including radioactive contamination stemming from the now defunct Semipalatinsk nuclear testing site, industrial metal waste contamination released from a copper-smelting plant on Lake Balkhash, and chromium and slags released from the Aktyubinsk Plant located adjacent to the Ilek river.

Kyrgyzstan has experienced contamination of waterways and groundwater with elevated levels of metals and production waste, coupled with bacterial and viral contamination of the drinking water.

In Moldova, the country has experienced an increase in the amount of insufficiently treated wastewater since 2000 [\[15\]](#). Based on the literature review, copper and zinc have been detected in the muscles and organs in multiple fish species that inhabit three freshwater systems in Moldova: the Cuciurgan reservoir, Prut river, and Dniester river [\[16\]](#). The range of averages for Cu and Zn in fish muscles across freshwater bodies was 8.2–10.3 µg/g (wet weight) and 26.4–30.2 µg/g (wet weight), respectively [\[16\]](#). The range of averages falls within the levels set by the United Nations Food and Agriculture Organization for Cu and Zn (Cu: 10–100 mg/kg, Zn: 30–100 mg/kg), but Cu levels exceed the levels set by the Ministry of Agriculture, Fisheries and Food (5 mg/kg for Cu and 50 mg/kg for Zn) [\[16\]](#). Additionally, excessive nitrates and nitrites in vegetables have been detected in the foothills and plains regions in Moldova [\[17\]](#). Moldova has also faced elevated fluoride levels in ground water sources. Fordyce et al. identified that the average fluoride levels in four out of the seven ground water sources sampled exceeded the WHO recommended maximum fluoride value of 1.5 mg/L (range: 0.41–3.1 mg/L), with six of the seven sites having maximum values that exceeded the WHO maximum fluoride level (range: 0.88–16.2 mg/L) [\[18\]](#).

The major aquatic issues in Romania include degradation of water along the Prut and Vedea rivers, which remain unsuitable for aquatic fauna,

Table 3 Summary of the aquatic health, zoonotic disease and foodborne disease issues in GeoHealth Hub countries based on the health needs assessment data.

Specific problems	Moldova	Kazakhstan	Armenia	Albania	Georgia	Kyrgyzstan	Romania
Aquatic health issues							
Pollution of water/rivers/lakes by metals, heavy metals, production waste, copper-smelting, oil, chrome and nitrate compounds, microbiological contamination, radioactive and non-radioactive eco-toxicants	X	X	X			X	X
Iodine and fluoride deficiency in drinking water	X						
Elevated fluoride, mineralization, nitrates/nitrites, arsenic, heavy metals, and oil, U238 from tailing dumps, and non-radioactive eco-toxins in groundwater	X		X	X		X	X
Waterborne diseases in drinking water					X		X
Need for improvement in quality of diagnosis and management for environmental health related health and developmental effects					X		
Bacterial and viral contamination of drinking water						X	
Foodborne disease/intoxication							
<i>Salmonella Typhi, Enteritidis</i>			X			X	
<i>Shigella sonnei</i>						X	
Hepatitis A virus						X	
Lack of knowledge in food safety (resulting in high incidence of infectious diseases)						X	
Vegetable culture, cereal pollution (by lead, metals, mycotoxins)		X					X
Staphylococcus			X				
Dysentery			X				
Botulism			X				
<i>E. coli</i> contaminated food			X				X
Toxic infection/foodborne illness outbreaks				X	X		
Need for improvement in quality of diagnosis for environmental health related and developmental effects in food safety education and training					X		
Histamine in fresh fish							X
Pesticides, heavy metals, pathogenic and conditionally pathogenic microorganisms, nitrites, nitrates and nitrosamides in food	X						X
<i>Salmonella</i>	X						
Zoonotic diseases							
Lyme disease	X						
Echinococcosis	X					X	

Table 3 Continued.

Specific problems	Moldova	Kazakhstan	Armenia	Albania	Georgia	Kyrgyzstan	Romania
Q fever	X						X
Rabies (in animals)	X					X	
Leptospirosis	X						
HPAI							X
<i>Toxoplasma gondii</i>							X
West Nile Virus							X
Crimean-Congo hemorrhagic fever virus							X
Anthrax			X			X	
Brucellosis		X	X	X		X	
Leishmaniasis			X				
Tularemia			X				
Intersectoral coordination for prevention and control of zoonotic diseases					X		
Evaluation of programs for prevention and control					X		
Listeriosis		X					
<i>Yersinia pseudotuberculosis</i>		X				X	
Chlamydiosis		X					
Total issues	10	6	11	3	6	12	12
Aquatic health	3	1	2	1	2	3	3
Foodborne disease/intoxication	2	1	5	1	2	4	4
Zoonotic disease	5	4	4	1	2	5	5

and contamination by high levels of minerals in major aquatic areas. For example, high levels of nitrates and phosphates exist in the Danube Delta and one study found elevated arsenic levels in drinking water sources from Bihor and Arad counties [19]. For example, out of the 134 water samples collected from six towns in western Bihor and Arad counties in 1995, 12.8% had arsenic levels above the WHO and Romanian standard of 50 µg/L (range: 0–176 µg/L) and 37.2% had levels above the provisional guideline values proposed by WHO and US EPA (>10 µg/L) [19]. Other issues include groundwater contaminated from oil, petroleum products, phenol compounds, fertilizers, and pesticides.

3.3. Literature review and HNA results for zoonotic diseases

The HNA provided insight regarding the presence and incidence of zoonotic diseases impacting humans in the seven target countries. However, a dearth of literature investigating zoonotic diseases was apparent for Armenia, Georgia, Kyrgyzstan, and Moldova. Unless otherwise noted, zoonotic disease rates apply to human cases.

In Albania, anthrax, brucellosis, and leptospirosis all exist, but at varying magnitudes. Annual incidence rates of anthrax in Albania have remained relatively constant when comparing rates in 2007 to 2011: the annual rates hovered around 1/100,000 during both years. The regions most affected by anthrax include Gjirokaster, Sarande, and Delvine in southern Albania. However, brucellosis, although on the decline, has an annual incidence rate of 14.3/100,000 in 2011, compared to 28.7/100,000 in 2007. Conversely, the annual incidence rates of leptospirosis have increased from 0.4/100,000 in 2007, to 0.7/100,000 in 2011. From 2000 until the present, cases of Crimean-Congo hemorrhagic fever have also been reported in several Balkan countries, including Albania [20]. The literature review also detailed the re-emergence of trichinellosis in Albania [21].

In Armenia, the HNA demonstrated that the following zoonotic diseases are significant problems: anthrax, brucellosis, leishmaniasis, and tularemia. In Georgia, the HNA revealed some shortcomings when it came to coordinating programs for prevention and control of zoonotic diseases, as well as an inability to evaluate current programs.

The major zoonotic diseases impacting Kazakhstan include brucellosis, *Yersinia pseudotuberculosis* infections, and chlamydiosis. The literature review revealed articles discussing the downward trend in plague cases (0 cases in 2004–2007) and in tularemia cases [22,23]. One article investigated the epidemiology of echinococcosis in a rural, eastern village in Kazakhstan. Results revealed 23 positive cases via ultrasound and 3 serologically, out of the 3,126 individuals investigated [24]. An additional 24 subjects in the cohort reported receiving treatment for echinococcosis [24]. The research also revealed that one of the most significant issues in Kazakhstan was the population's low level of understanding regarding zoonotic diseases and shortcomings in disease treatment spanning from clinicians' insufficient knowledge, to a lack of standardized protocols for zoonotic disease management.

For Kyrgyzstan, the HNA identified the following zoonotic diseases as endemic in the country: echinococcosis, rabies (in animals), anthrax, brucellosis, and *Y. pseudotuberculosis*. For Moldova, the HNA identified several zoonotic diseases impacting the country including Lyme disease, echinococcosis, Q fever, rabies (in animals), and leptospirosis.

Lastly, for Romania, the literature review identified two articles: one investigated seroprevalence rates of *Toxoplasma gondii* in pigs and the other on *Anaplasma phagocytophilum* in wild boars. The first study demonstrated higher rates of *T. gondii* in domestic swine (23.1%) compared to wild boars (16%), and higher seroprevalence rates in backyard pigs (30.5%) when compared to swine living in confined animal feeding operations (0%) [25]. The other report found that *A. phagocytophilum* naturally infected wild boar populations in Transylvania [26]. HNA results revealed that Q fever, highly pathogenic avian influenza (HPAI), *T. gondii*, West Nile virus, and Crimean-Congo hemorrhagic fever virus serve as important zoonotic pathogens in Romania.

3.4. Literature review and HNA results for food safety

The literature review revealed sparse data in terms of foodborne diseases for the seven countries. However, based on the HNA, a great diversity of food safety issues exist for the target countries spanning from chemical and bacterial contamination of the food supply, to inadequate foodborne illness education and training in the population and in practitioners, respectively.

For Albania, the literature review uncovered a study that found lead intoxication in humans stemming from contaminated flour [27]. The HNA results echoed these findings and also determined that foodborne illness outbreaks serve as health issues in Albania. For Armenia, the literature review identified one article that found serious soil and air contamination by persistent organic pollutants (POPs) at four obsolete pesticide storage sites [28]. This resulted in increased POP levels in food items that originated from grazing animals in the area [28]. Based on the HNA, Armenia has also experienced an increase in the number of infections and outbreaks from *Salmonella*, *Escherichia coli*, dysentery, and botulism in recent years. No related published literature from Georgia was found; however, the HNA found evidence of foodborne illness outbreaks in Georgia and documented a gap in the education and training of health care professionals for foodborne illness diagnosis.

In Kazakhstan, the literature review yielded no articles regarding food safety, but the HNA demonstrated that Kazakhstan suffers from vegetable and cereal contamination with metals related to irrigation waters from the Nura River. In Kyrgyzstan, the HNA uncovered evidence of outbreaks related to *Salmonella*, *Shigella sonnei*, Hepatitis A, *Brucella melitensis*, along with a lack of food safety knowledge in the general public.

In Moldova, the literature uncovered vegetable contamination with nitrites and nitrates [17] and the HNA also found similar results regarding nitrate and nitrite contamination of foods. For Romania, the HNA revealed evidence of vegetable and cereal contamination with metals and mycotoxins, the presence of *E. coli*-contaminated food, histamine in fresh fish, and contamination of foods with nitrates, nitrites, pesticides, and heavy metals. One literature review article detected evidence of *Listeria monocytogenes* in food products [29].

4. Discussion

The evidence provided by the literature review and HNA from the seven GeoHealth Hub countries identified a great diversity of health problems in the areas of aquatic health, zoonotic diseases, and food safety. Most of the problems are complex, involving multiple disciplines and merit a One Health approach to study and mitigate. Drawing upon the diverse expertise of veterinary, human and environmental health professionals comprising the GeoHealth Hub, collaborators aim to use this baseline information to shape pilot mitigation

research studies to ameliorate these important environmental and occupational health problems in the target countries.

4.1. Study limitations

Although the study aimed to design a strong methodology, several limitations involving communication, HNA design, data source heterogeneity and reliability, coupled with perceptions regarding One Health-based interventions could have potentially influenced the study findings. In terms of communication, not all partners involved in direct data collection could benefit from face-to-face meetings and trainings. Moreover, since English is not a native language for any of the LMICs, there is presumably some information that could not be fully transmitted. For example, during the first trip to all partner countries, we met face-to-face with some collaborators and instructed them on how to use the health needs assessment template. However, after we left, additional collaborators were recruited to perform data collection, and some of them did not speak English.

Secondly, communities, environments, and resources vary by country; likewise, the sources for collecting data and hence, populating the HNA also differed. Most of the existing HNA tools have been designed for specific purposes, resulting in a narrow scope and a limited number of parameters. This limits their relevance for studying complex environmental health topics.

Thirdly, the data sources from target countries were diverse and seemed to vary in quality and veracity. To minimize the impact of reduced data reliability, we formulated a layered strategy to obtain data. For example, we combined data from the literature review with data from the HNA and interpreted these data with expert technical interpretation. Other challenges included limited spatial and temporal data availability, limited development of data sharing mechanisms, a lack of adequate methodologies to link disparate data sources, and in some settings, a low level of interdisciplinary cooperation between stakeholders that share different accountabilities [30].

Finally, since most of the target countries were formally under communist rule, public health was organizationally considered a component of chemical medicine. This likely influences the data that were available for review and the national stakeholders regarding environmental and occupational problems.

5. Conclusions

This report reveals the most important occupational and environmental health problems impacting the

seven GeoHealth Hub target countries. The report establishes baseline needs in terms of aquatic health, zoonotic diseases, and food safety among target countries and establishes the need to approach these diverse issues with a multi-disciplinary, One Health approach. The GeoHealth Hub will now use these data to design pilot research programs to mitigate these problems.

Conflict of interest

None declared.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jegh.2015.04.004>.

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