Environmental Network Research Center
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Environmental Network Journal (ISSN 2752-8294)
Volume 1, Article no. 4, December 2022

Nexus of Environmental Education and Public Health Surveillance of Re-emerging Diseases and Covid 19 using Artificial Intelligence

Kunda Nyirongo

To cite this article: Nyirongo, K. (2022), 'Nexus of Environmental Education and Public Health Surveillance of Re-emerging Diseases and Covid 19 using Artificial Intelligence', *Environmental Network Journal*, 1:4

1. Abstract

The outbreak of the novel coronavirus disease (COVID-19) has made the adoption of change in human behaviour and attitudes, the "new normal", which calls for the integration and relevance of environmental education in addressing the COVID-19 pandemic on surveillance and sensitization. This viewpoint article discusses how artificial intelligence and environmental education could be mainstreamed in surveillance of COVID-19 and other re-emerging diseases. The current viewpoint fills this gap by presenting a critical analysis of several studies on the nexus between COVID-19 and environmental education. The aim of the review is to understand the links between environmental exposures and COVID-19 along with the association with environmental education. The author proposes an assessment tool which could be used in public health surveillance of COVID-19 and other re-emerging diseases, so as to compute their cumulative impact on people's health and determine efficient prevention and control counter-measures. In this regard a systematic review was undertaken to synthesize the evidence that environmental education and artificial intelligence should be used in the surveillance of COVID-19 and other re-emerging diseases such as Ebola and Monkey Pox. To conduct this review, Google Scholar, Pubmed and Research Gate were utilised between January and August 2022. Only peer reviewed, English language studies on Environmental education, Artificial Intelligence, Surveillance on Covid-19 and other remerging diseases were selected for the review.

Keywords

COVID-19; Environmental Education; Environment; Artificial Intelligence; Public Health; Resurface Assessment Tool

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2. Introduction

The appearance of a previously known infection after a period of disappearance or decline in incidence is known as remerging infectious diseases (Lau et al, 2020). Emerging infectious diseases (EIDs) are defined as diseases that are newly identified, newly introduced, or newly evolved; or diseases that have recently and rapidly changed in incidence or expanded geographic, host, or vector range agents; or previous infections that acquired new virulence factors; or infections that spread to unaffected regions (Kow Toy, 2022). In his study, he noted that remerging and emerging infectious diseases cause a huge economic crisis and public health problems in the world. It is postulated that the origins of re-merging and emerging infectious diseases are significantly correlated with socio-economic, environmental, and ecological factors and provide a clue for identifying regions where new EIDs are most likely to originate (Wu et al, 2020).

Previous studies conducted by Lau et al (2020), Wu et al (2020) and Lin et al (2022) have shown that the morbidity of re-emerging and emerging diseases is increasing and that most re-emerging and emerging diseases are caused by zoonoses (60.3%), the majority of which (71.8%) originate in wildlife. Many EIDs are zoonotic; organisms grow in animals with random transmission into the human population; EID may also be foodborne, vector-borne, or air-borne, such as Spanish flu, severe respiratory syndrome coronavirus (SARS-CoV), Middle Eastern respiratory syndrome coronavirus (MERS-CoV), and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Munyua et al 2019).

To address this threat, national and international disease management public health systems have to be strengthened, and networks built to facilitate the application of Artificial intelligence (AI) techniques in infectious disease outbreak detection and early warning, trend prediction, and public health response modelling. The growing literature on the AI-enabled or -enhanced public health surveillance work illustrates the research community's interest in applying AI techniques, as part of the research community's response to the COVID-19 pandemic and other re-emerging diseases such as monkey pox, ebola and others, as a call for developing AI-based public health solutions with integration of other social science disciplines such as environmental education. This viewpoint article therefore discusses how

artificial intelligence and environmental education could be mainstreamed in surveillance of COVID-19 and other re-emerging diseases.

3. Methods

A systematic literature review was conducted, using the review guidelines by the Arksey and O'Malley Framework (2005). The author considered the recent review framework in strengthening the review stages. The methods reported in Arksey and O'Malley's five recommended stages of scoping reviews were adapted and applied, as outlined below.

3.1 Research Question

A research question was formulated to guide the scoping review. The aim of this review is to understand how artificial intelligence and environmental education could be mainstreamed in the public health surveillance of COVID-19 and other re-emerging diseases. The specific question was: What factors can contribute to the integration of environmental education and artificial intelligence in the surveillance of re-emerging diseases and Covid-19?

3.2 Literature Identification

A full preliminary search to identify relevant indexed peer-reviewed articles from January to August, 2022 was conducted so as to ensure the validity of the proposed idea, avoid duplication of previously addressed questions, and assure that the articles were adequate to conduct the analysis. The systematic review targeted scientific documents on environmental education, Artificial Intelligence (AL), re-emerging and emerging diseases, surveillance methods, and systems and approaches related to early detection. The literature search was performed using PubMed/MEDLINE (National Library of Medicine); EMBASE (Excerpta Medica dataBASE); Google Scholar and Research Gate, which cover more than 90% of public health and medicine journals. The literature search was restricted to documents written in English (for reviewing convenience) that have been published over the last 30 years to represent the most up-to-date scientific information. This search included published articles, conference proceedings and reports. The aim of this scoping review was to understand the nexus of environmental education and public health surveillance of re-emerging diseases and Covid 19 using artificial intelligence. In all, 35 papers satisfied

the eligibility criteria and were included by consensus agreement using the PRISMA guideline as shown in Figure 1.

3.3 Study Selection

Studies were included based on the inclusion and exclusion criteria highlighted in Table 1. Included studies were limited to original studies (e.g., quantitative, qualitative), Non original studies were excluded along with studies not written in the English-language.

Table1: Inclusion and Exclusion Table

Criteria	Inclusion	Exclusion
Study Type	Original Studies (Quantitative and Qualitative)	Non-Original Studies such as letters and editorials.
Language	Studies published in the English language	Studies not published in the English language
Date	Studies produced from any date until August 30, 2022	N/A

3.4 Data Analysis

Under this review, 35 articles were read and reviewed in order to summarize the methodology and discussion. The author undertook a literature quality assessment, extracted data from the literature, included them into a spreadsheet, and analysed the data independently. Under selection, a review of original articles was conducted independently by the author to ensure the article met pre-determined criteria for inclusion. Quality and methodology were evaluated rigorously by using modified mixed-methods appraisal tool (MMAT) (Hong et al, 2018). Descriptive analyses of the collected data were performed. Variables were analysed separately and in combination in order to obtain as much information as possible from the articles. A special focus was the identification of the main applications, benefits and constraints of each type of methodology found in the review.

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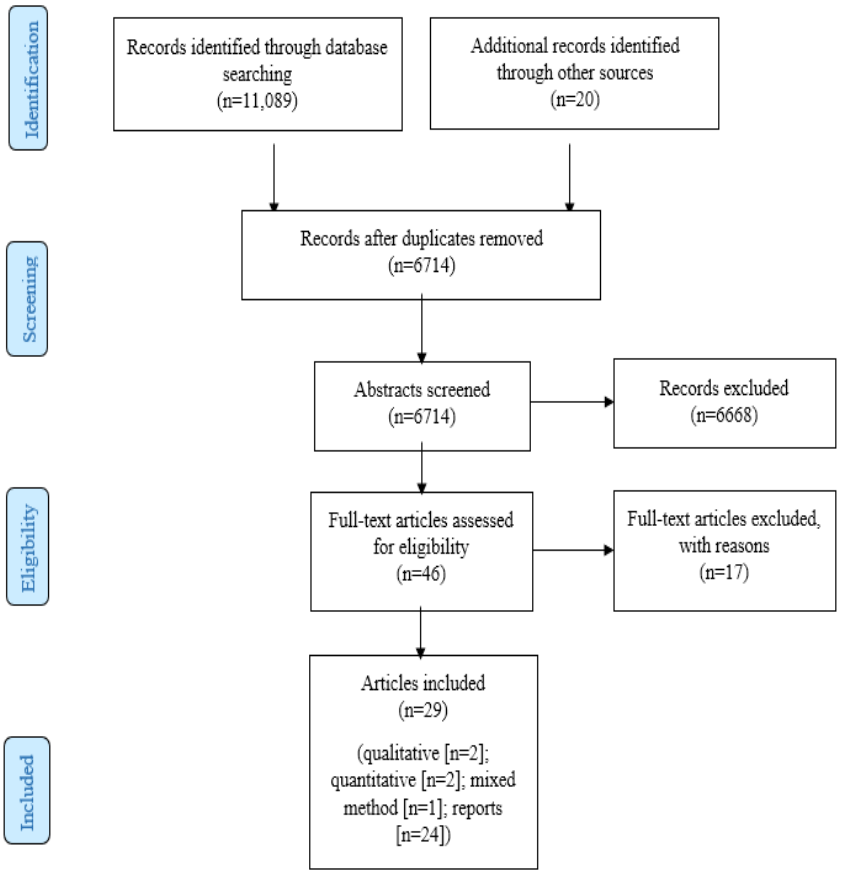

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart of the literature review.

3.5 Selection Results

Among the 35 articles identified across PubMed, Embase, Research Gate, and Google Scholar platforms, which met the search criteria for understanding the nexus of environmental education and public health surveillance of re-emerging diseases and Covid 19 using artificial intelligence, 33 articles were used during the analysis of which 2 articles were excluded due to irrelevance. Duplicates were removed during literature identification. Of the 33 full original studies reviewed, 18 were articles on Covid 19, remerging and emerging infectious diseases from across countries such as China, Turkey, Kenya, and the United States of America. 12 studies focused on Environmental Education and its impact of changing attitudes

and creating sensitization during epidemics when integrated in other science disciplines in Africa and America. 4 studies were based on understanding the use of Artificial Intelligence in public health surveillance.

4. Results

Inclusively, this comprehensive systematic review revealed the inadequacy of literature on Environmental Education during epidemics in Africa. Surprisingly, a number of studies only covered information on artificial intelligence and emerging diseases on two pandemics (Ebola and COVID-19) though there have been several other disease outbreaks, such as influenza, bubonic plague, cholera, yellow fever, meningitis, measles, rift valley fever, polio and the recent monkey pox in Africa. Similarly, the literature lacked variety in public health surveillance outcomes. 33 of the studies considered artificial intelligence and emerging diseases such as COVID-19 with no studies evaluating the importance of integrating environmental education in public health surveillance or factoring it in diseases caused by environmental factors. This lack of integration/information on/of environmental education is worrisome given the re-occurrence of emerging diseases influenced by environmental factors that call for a change in attitude and behaviours among populations.

4.1 Environmental Factors Influencing Remerging Diseases and Covid-19

The correlation of COVID-19 and the environment has been evident in literature, with environmental or climate factors having a significant influence on COVID-19 transmissions and mortality. Several studies such as Bashir et al. (2020), Carrington (2020), Şahin (2020) and Zhu et al. (2020), have reported a significant correlation between climate indicators such as temperature, humidity, rainfall, and wind speed with COVID-19 transmission rates. Bashir et al. (2020) stated that quality of air significantly increased the spread of COVID-19 infections in New York City. In addition, Şahin (2020) and Zhu et al. (2020) examined the influence of weather and meteorological factors on COVID-19 transmissions in the cases of Turkey and China. Respectively, Şahin (2020) reported positive associations of wind speed and crowd in cities with high COVID-19 transmission rates. Ma et al. (2020) considered air movements and pollution as a crucial indicator that affects COVID-19 transmission due to particulate matter movements at a high rate. Ma et al's (2020) study is in correlation with a study in Northern Italy, where parts of the city with polluted air, was struck relatively hard by COVID-19 than the rest of the country parts which atmosphere was less polluted (Carrington, 2020). Therefore, COVID-19 is likely to be influenced by environmental factors. With this phenomenon, it was noted that most studies are largely focused on reporting the biological factors

causing COVID-19 than the environmental factors, less the integration of environmental education with COVID-19 and other re-emerging diseases.

In 2002, Severe Acute Respiratory Syndrome (SARS), a new, highly contagious, viral disease, emerged in China and quickly spread to 32 countries causing an excess of 774 deaths and 8098 infections worldwide (Gumel et al., 2004). As at now the putative pathogen of SARS has been identified as a new coronavirus known as COVID-19. The re-emergence of SARS as COVID-19 in the Wuhan province in China entails inadequacy in the monitoring of ongoing public health surveillance and data collection systems before, during, and after the implementation of a disease control program (Budd et al., 2020). The SARS experience denotes that inadequate surveillance and response capacity in a single country can endanger national populations and the public health security of the entire world (Post et al., 2020). The national and international response to the SARS outbreak, tested the assumption that a new and emerging infection- one that had not yet demonstrated its full epidemiologic potential but was spreading from person to person and continent to continent could have been prevented from becoming endemic and re-emerging as COVID-19, with a vigorous public health surveillance system and an environmentally sensitive population (Lin et al., 2022).

COVID-19, a previously unknown respiratory illness caused by the coronavirus SARS-CoV-2, was declared a pandemic by the World Health Organization (WHO) on 11th March 2020, less than 3 months after cases were first detected (Sani et al., 2020). It was stated that the coronavirus belongs to a family of viruses that may cause various symptoms such as pneumonia, fever, breathing difficulty, and lung infection (Adhikari et al., 2020). The World Health Organization (WHO) used the term 2019 novel coronavirus to refer to a coronavirus that affected the lower respiratory tract of patients with pneumonia in Wuhan, China on 29 December 2019 (Subbian et al., 2021).

The cause of COVID-19 was attributed to the Huanan South China seafood marketplace, though no specific animal association was identified, however Coronaviruses are zoonotic diseases, implying that they first spread to people from animals (Hussein et al., 2020) as was the case of SARS where the original hosts were bats. The bats then infected other animals, which transmitted the virus to humans (Lau et al., 2020).

However, epidemiological evidence suggests that environmental exposures influence the occurrence and severity of COVID-19. Suffice to mention that the coronavirus spreading and the SARS outbreak of 2002 have certain similarities: Both are from the coronavirus family, both started in environmentally wet markets, both were deemed as highly infectious viruses and spread internationally (Gumel et al., 2004). According to some reports, more than 50% of emerging or re-emerging infectious diseases are of zoonotic origin; i.e. transmitted to humans from animals, either directly or through intermediate hosts (Kilpatrick and Randolph, 2012). This includes avian influenza, SARS/MERS/SARS-2 coronaviruses, Nipah virus and many others.

Hence all countries are required by the International Health Regulations (2005) to have core capacity to ensure national preparedness for infectious hazards that have the potential to spread internationally (Vilbert, 2021). The most challenging question in science as at now is: can these pandemics be predicted? Predicting when such a 'zoonotic' disease will initiate an outbreak remains perplexing. However, some studies suggests that artificial intelligence (AI) could play a role in this regard as noted by Hussein et al. (2020). Without effective interventions, the rapidly increasing number of re-emerging diseases will greatly increase the burden of clinical treatments. Identifying the transmission sources and pathways is of vital importance to block transmission and allocate limited public health resources (Adhikari et al., 2020).

During the outbreak of severe acute respiratory syndrome in 2003, Hong Kong identified clusters of disease through the use of electronic data systems (Gostin et al., 2020). Similarly with the Ebola outbreaks in West Africa within 2014–2016, mobile phone data were used to model travel patterns, and hand-held sequencing devices permitted more-effective contact tracing and a better understanding of the dynamics of the outbreaks. These outbreaks also emphasized the need for a global public health surveillance and response mechanism. Public health surveillance is a necessity in estimating the health status as well as behaviour of the populations served by ministries of health, ministries of finance, ministries of livestock, research organisations, non-governmental organisations, donors and international organisations on a global level such as: World Health Organisation, United Nations, United Nations Development Program, Global Outbreak Alert and Response Network, Global Emerging Infectious Surveillance and Response System.

4.2 Use of AI in Public Health Surveillance of Remerging Diseases and Covid-19

The purpose of using artificial intelligence (AI) in the surveillance is to empower decision makers to lead and manage more effectively by providing timely and useful evidence in mitigating outbreaks at the onset. Artificial intelligence (AI) is one of the means or avenues to understand the viruses and develop preventative and control measures. This includes but is not limited to: the usage of mathematical modelling to understand virus transmission, structural biology to determine virus structure and develop vaccines, and computational biology to understand virus evolution and environmental factors (Gumel et al., 2004). AI-based systems are already being deployed to diagnose coronavirus infection in China. A system named 'Coronavirus Chest CT Smart Evaluation System' developed by YITU technologies for the Shanghai Public Health Clinical Centre (SPHCC) can now diagnose the suspected cases within seconds (Luo et al., 2021). For this viewpoint review, the author proposes a surveillance and response system in a digitalised era that utilizes sophisticated computer modelling to simulate a biological experiment for medical analysis screening, a tool that mimics Molecular subtyping i.e., expanding the power of laboratory-based surveillance to detect outbreaks (Budd et al., 2020) through distinguishing the molecular "human body" of an outbreak strain without using blood in identifying the viruses. The proposed scientific tool called the "AI resurface surveillance tool" will be able to screen different pathogens or viruses, which will be imitated in its system such as strains of SARS, COVID-19, and EBOLA, so as to detect the viruses at an early stage in the human body. The AI resurface surveillance tool, will have the body of a booth which allows an individual to stand inside the booth for screening,

The said tool in question shall be implemented in hospitals, where mandatory screening shall be enforced mainly for people who work in wet markets, individuals involved in animal farming, and frequent travelers. Duration of screening will be conducted every 1 month for at risk populations and 3 months for the generalised population. The artificial intelligence tool will enhance efforts in collecting timely data, analysing the collected data, perceiving human thoughts in understanding disease information/extent of awareness and using the generated information for public health responses. To design the resurface assessment tool will require a scientific investigative and experimental research involving: biomedical

scientists, biologists, medical doctors, epidemiologists, public health specialists, computer scientist, artificial intelligence engineers and environmental educators.

4.3 Introduction of the Resurface Screening Assessment Tool and the Integration of Environmental Education in Public Health Surveillance Remerging Diseases and Covid-19

Designing the resurface assessment tool and integrating environmental education (EE) as a part of the screening process will bring an education awareness component and will enhance the importance of environmental education in technology (Purwanto et al., 2020). Mainstreaming environmental education in to the COVID 19 resurface assessment tool will aid an increase in personal inquiry and critical thinking through ease of access to information related to scientific questions and observations. The proposed booth will interact with people by questioning the previous environments they have visited and highlight to them if they have been in an environment that may have likely exposed them to a new virus or a re-emerging virus. Based on input from environmental educators in to surveillance tool, the resurface assessment tool will caution an individual on living harmoniously with the environment to avoid the spread of public health diseases. Yet the drawbacks of integrating EE into artificial technology is if mainstreaming will be possible and effective? Or, could it be the appropriate and meaningful use of EE in technology and be part of the solution to public health surveillance on remerging diseases using environment education? EE is known as an on-going learning process. Hence EE in science entails that sensitization of COVID-19 and other re-emerging diseases will be an on-going process with more cautious and alert people (Purwanto et al., 2020) and (Subbian et al., 2020). According to Keselman et al. (2011), Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible actions. Therefore, it can be noted that environmental education will equip people and societies with the skills, knowledge and perspectives to live in an ever-changing world environmentally in the face of diseases. As pointed from the review above in the Introduction, COVID-19 emerged in an environmental risk where people in a market had little to no awareness on the effects of harbouring

animals in a certain environment and the contribution to breed up certain viruses and bacteria due to the environment having host factors (Post et al., 2020).

However, the relevance of environmental education has not been widely publicized. Yet the UN conference on environment and development in 1992 recognised the importance of education in achieving sustainable development and a whole chapter of the accompanying action plan called Agenda 21 was dedicated to improving the capacity of people to address environment and development issues (Turkoglu 2019). The 2002 Johannesburg World Summit on Sustainable development reaffirmed the educational objectives of the Millennium Development Goals and the EFA Dakar Framework for Action and declared the Decade of Education for Sustainable Development 2005-2014. The UN Decade of Education for Sustainable Development aims to promote education as a basis for a more sustainable human society and to integrate sustainable development into education systems at all levels (Ugulu et al., 2013) and (Keselman et al 2011). Environmental Education was globally recognised during certain important declarations, perhaps the two most important historical contexts to focus on are the Tbilisi Declaration and the Belgrade Charter. While the Belgrade Charter was created first in 1972, the Tbilisi Declaration was adopted in 1977 as the official guidelines concerning environmental education worldwide (Vidergor 2015). The United Nations Education, Scientific, and Cultural Organization (UNESCO) and the U.N. Environment Programme (UNEP) were the next to state the purpose of environmental education. Both historical pieces represent the beginning of environmental education as we now know it. These high-level meetings and policy statements signified the increasing importance of environmental education on the political agenda at international and national levels. They also brought forward the theme of sustainable development. Most importantly, the objectives listed under the declaration awareness, knowledge, attitudes, skills, and participation cover the necessities to produce generations of environmental stewards and mainstreaming it with other sciences/technology (Miarsyah et al., 2019). These objectives, coupled with the declaration's focus on creating sustainably built environments, laid the foundation for effective environmental education that is still utilized today.

Therefore, integrating environmental education in to the resurface assessment tool is cultivating a relationship with nature and technology. In this perspective, technology is seen as cumulating ties to the

environment, as it improves critical- thinking and problem-solving skills; and relate understanding of the environment and public health to the needs and issues of the community. Environmental education can help to prevent or mitigate environmental human health problems by providing the public with information on the causes of environmental factors that increase or host the breeding of certain viruses and bacteria to cause pandemics. It also gives knowledge on how to assess real versus exaggerated environmental public health risks, and how to make informed and responsible decisions. For instance, Peffer et al. (2013) describes how technology and education can connect children and adults to global issues and promote education related to complex and abstract concepts. Digitally-mediated practices, such as podcasting, remote monitoring, digital recording, and videoconferencing, usually lead to engagement with real-world data and the ability to overcome "geographic, cultural, and emotional barriers to learning and understanding through authentic investigations" (Peffer et al., 2013, p. 20).

Personal digital assistants, or PDA's, have demonstrated to be an effective tool to access web-based outdoor educational activities, along with facilitating assessments during outdoor excursions (Sandri 2012), and serve as a means for enhancing behavioural/attitude change (Kalkan et al., 2012). These studies suggest that mobile technology promotes and enhances mainstreaming education and technology, collaboration and interaction when compared to traditional forms of instruction, and thus provides a means for accessing, investigating, and sharing environmental concerns through media without being limited by place and time. Furthermore, Purwato et al. (2020) observed that the use of PDA's, now referred to as mobile devices, and other mobile technologies, led to a greater level of engagement in environmental education activities and an increase in long-term environmental knowledge retention among children and adults. Hence Environmental Education should not only be boxed, to not just depleting natural resources and protecting human rights but instilling environmental norms and values that foresees to it that the earth is protected from not only environmental disasters such as earthquakes, volcanoes etc., but diseases.

Environmental education has tremendous potential to contribute to the goals of health reforms. With the resurface assessment tool understanding impacts of toxic environmental exposures including dirty environment, air pollution, chemical and metal exposures on innate immunity, especially in the

respiratory epithelium will enable countries to track their national well-being and ascertain the environmental risks that could lead to public health diseases. The resurface assessment tool integrated with environmental education will produce citizens who are environmentally literate and can exemplify environmental health concerns for social action (Keselman, et al., 2011). At the same time, environmental education can promote interdisciplinary understanding for the reason that environmental topics can be addressed from many different perspectives, including scientific, historical, and cultural. Environmental education can also bring local environmental challenges into the daily life judgement to improve analysis and problem- solving skills (Sandri, 2012).

4.4 Steps in Implementing the Resurface Screening Assessment Tool

The importance of environmental awareness, environmental sensitiveness and environmental consciousness is indisputable for healthy human-nature relationships. The social roots of the coming global pandemic crisis lie largely in the very structures of the present awareness of society for environment and values inherent in the way they function. It is a necessity to inform individuals about environmental issues and raise awareness among them in such way to ensure behavioural changes. The purpose of environmental education and training is to provide individuals with the ways and means to effectively and responsibly protect not only resources from the environment but to understand the nexus of public health pandemics and the environment. Thus the key steps in implementing the resurface assessment public health surveillance tool will include: lobbying for financial resources for developing the resurface screening assessment tool, sensitizing key health authorities, stakeholders; conducting situational analysis; identifying and training a motivated, competent workforce; developing national technical guidelines; implementing the plan; and monitoring and evaluating the implementation to improve performance of the resurface assessment tool. The final aspect of environmental education policies, but certainly not least important, is training individuals to thrive in a sustainable society, in addition to building a strong relationship with nature.

Environmental Network Journal (ISSN 2752-8294)
Volume 1, Article no. 4, December 2022

5 Conclusion

The above systematic review creates an awareness of mainstreaming Environmental Education and Artificial Intelligence in the surveillance of re-emerging infectious diseases and Covid-19. Although the systematic review undertaken in this viewpoint highlights a lack of literature on environmental education during epidemics, and an absence of literature on public health surveillance outcomes, the author proposes the development of a resurface screening assessment tool that integrates both Environmental Education and Artificial Intelligence with a view of early detecting diseases before they become pandemics or endemics and strengthen Public Heath Surveillance. Additionally, from the studies in this systematic review, it can be noted that advances in artificial intelligence (AI) have proven useful in many research domains and have been applied successfully in various health-related fields. However, in the field of Public Health it is still behind the curve in comparison to others. In Scientific disciplines AI may be incorporated in health care for improving medical care especially in handling big data, exponential computing power and ever-increasing demand on health care system. Environmental Education is linked to enhancing awareness on human behaviours and environmental factors that influence the spread of re-emerging diseases and assist in early detection. The review also aims to create awareness among Public Health professionals including policy makers regarding the use of advanced technologies, as the practical application of such technologies will improve their widespread implementation with increased support and funding. Thus, AI ensures tremendous promise with regards to health care services in developing countries. However, there may be certain obstacles but they could be addressed and overcome using the AI support as well as other technological advancements. Public health outcomes can be improved by using several AI applications such as ubiquitous use of smart phones, cloud computing etc.

References

ADHIKARI, S. P., MENG, S., WU, Y.-J., MAO, Y.-P., YE, R.-X., WANG, Q.-Z., SUN, C., SYLVIA, S., ROZELLE, S., RAAT, H. & ZHOU, H. (2020). Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. *Infectious Diseases of Poverty,* 9**,** 29

ALDIG, E., & ARSEVEN, A. (2017). The contribution of learning outcomes for listening to creative thinking skills. *Journal of Education and Learning*, 6(3), 41–53. https://doi.org/10.5539/jel.v6n3p41

BANDYOPADHYAY, S. (2020). Coronavirus Disease 2019 (COVID-19): We shall overcome. *Clean Technologies and Environmental Policy.* https://doi.org/10.1007/s10098- 020-01843-w.

BUDD, J., MILLER, B. S., MANNING, E. M., LAMPOS, V., ZHUANG, M., EDELSTEIN, M., REES, G., EMERY, V. C., STEVENS, M. M., KEEGAN, N., SHORT, M. J., PILLAY, D., MANLEY, E., COX, I. J., HEYMANN, D., JOHNSON, A. M. & MCKENDRY, R. A. (20200. Digital technologies in the public-health response to COVID-19. *Nature Medicine,* 26**,** 1183-1192.

CARRINGTON, D. (2022, November 1). *Air pollution linked to far higher Covid-19 death rates, study finds*. https://www.theguardian.com/environment/2020/apr/07/air-pollution-linked-to-far-higher-covid-19-death-rates-study-finds

ELFEKY, A. I. M. (2018). The effect of personal learning environments on participants' higher order thinking skills and satisfaction. *Innovations in Education and Teaching International*, *00*(00), 1–12. https://doi.org. /10.1080/14703297.2018.1534601

ERDURAN, S. (2020). Science education in the era of a pandemic: How can history, philosophy and sociology of science contribute to education for understanding and solving the COVID-19 crisis?. *Science & Education*, *29*, 233–235. https://doi.org/10.1007/ s11191-020-00122-w.

GOSTIN, L. O., MOON, S. & MEIER, B. M. (2020). *Reimagining global health governance in the age of COVID-19*. American Public Health Association.

GUMEL, A. B., RUAN, S., DAY, T., WATMOUGH, J., BRAUER, F., VAN DEN DRIESSCHE, P., GABRIELSON, D., BOWMAN, C., ALEXANDER, M. E. & ARDAL, S. (2004). *Modelling strategies for controlling SARS outbreaks.* 271**,** pp 2223-2232.

Hong Q. N., Fabreugues, S., Bartlett G., Biardman F., Crago M., & Dagenais P. (2018). The Mixed Methods Appraisal Tool (NMAT) Version 2018 for information professionals and researchers. 18(34), 285-291

HUSSEIN, M. R., APU, E. H., SHAHABUDDIN, S., SHAMS, A. B. & KABIR, R. J. A. P. A. (2020). *Overview of digital health surveillance system during COVID-19 pandemic: public health issues and misapprehensions*.

KALKAN, T., GÜRSOY, B., SALALI, E., ERDOĞAN, N & ERDEM, (2012). A Universal View to Environmental Education. *Biyoloji Bilimleri Araştırma Dergisi*,5 (1), pp 69-73

KESELMAN, A., LEVIN, D., KRAMER, J., MATZKIN, M., & DUTCHER, G. (2011). Educating Young People about Environmental Health for Informed Social Action. *Umw Gesundh Online*, 4, 1-8. https://www.ncbi.nlm.nih.gov/pubmed/24383062

KILPATRICK, A. M. & RANDOLPH, S. E. J. T. L. (2012). *Drivers, dynamics, and control of emerging vector-borne zoonotic diseases*, 380**,** 1946-1955.

KOW T. C. (2022). *Emerging Infectious Diseases and One Health: Implication for Public Health*

LUO, C., MA, Y., JIANG, P., ZHANG, T. & YIN, F. (2021). The construction and visualization of the transmission networks for COVID-19: A potential solution for contact tracing and assessments of epidemics. *Scientific Reports,* 11**,** 8605

Lau, S.K.P.; Luk, H.K.H.; Wong, A.C.P.; Li, K.S.M.; Zhu, L.; He, Z.; Fung, J.; Chan, T.T.Y.; Fung J.; Chan, T.T.Y.; Fung, K.S.C.; Woo, P.C.Y. (2020). Possible bat origin of severe acute respiratory syndrome coronavirus 2. *Emerg. Infect. Dis., 26*, 1542–1547.

Lin, C.Y.; Su, S.B.; Chen, K.T. An Overview of Gastrointestinal Diseases in Patients with COVID-19. Epidemiology and Pathophysiology: A Narrative Review. *Medicine*, In-Press

M.A. Zambrano-Monserrate, M.A. Ruano, L. Sanchez-Alcalde. (2020). Indirect effects of COVID-19 on the environment Sci. *Total Environ*., 728

M.F. BASHIR, B. MA, BILAL, B. KOMAL, M.A. BASHIR, D. TAN, M. BASHIR. (2020). Correlation between climate indicators and COVID-19 pandemic in New York, USA
Sci. *Total Environ*. (p. 72821)

Miarsyah, M., Sigit, D. V., Ichsan, I. Z. Fadrikal, R., Suprato M. (2019). Lekersmulia: Improving Indonesian Students' environmental responsibility using multimedia in environmental learning. International Journal of Scientific and Technology Research, 8(12). 1639-1643. http://www.ijstr.org/final-print/dec2019/Lekersmulia-Improving- Indonesian- Students-Environmental-Responsibility-Using- Multimedia-In- Environmental-Learning.pdf.

M. ŞAHIN.2020 Impact of weather on COVID-19 pandemic in Turkey. *Sci. Total Environ*., 728

Munyua, P. M., Nienga, M.K., Osoro, E. M., Onyango, C. O., Bitek, A. O., Mwatondo, A., Muturi, m. K., Musee, N., Bigogo, G., & Otiang E. (2019) Successes and Challenges of the One Health approach in Kenya over the last decade. BMC Public Health, 19(3), 1-29

PEFFER, T., BODZIN, A., SMITH, J. (2013). The use of technology by nonformal environmental educators. *The Journal of Environmental Education*, 44(1), 1

POST, L. A., ISSA, T. Z., BOCTOR, M. J., MOSS, C. B., MURPHY, R. L., ISON, M. G., ACHENBACH, C. J., RESNICK, D., SINGH, L. N. & WHITE, J. (2020). Dynamic public health surveillance to track and mitigate the US COVID-19 epidemic: Longitudinal trend analysis study. 22, e24286.

PURWANTO, A., NURJAYADI, M., SULUYA, R., & ICHSAN, I. Z. (2020). EM-SETS: An integrated e-module of environmental education and technology in natural science learning. International Journal of Advanced Science and Technology, 29(3), 7014–7025. http://sersc.org/journals/index. php/IJAST/article/view/7561.

SANDRI, OJ. (2012) Exploring the Role and Value of Creativity in Education For Sustainability. Environmental Education Research.

SUBBIAN, V., SOLOMONIDES, A., CLARKSON, M., RAHIMZADEH, V. N., PETERSEN, C., SCHREIBER, R., DEMURO, P. R., DUA, P., GOODMAN, K. W. & KAPLAN, B. J. J. O. T. A. M. I. A. (2021). Ethics and informatics in the age of COVID-19: challenges and recommendations for public health organization and public policy. 28, 184-189.

TÜRKOGLU, B. (2019). Opinions of Preschool Teachers and Pre-Service Teachers on Environmental Education and Environmental Awareness for Sustainable Development in the Preschool Period. Sustainability, 11(4925), 1-35. https://doi.org/10.3390/su11184925

UGULU, I., SAHIN, M., & BASLAR, S. (2013). High school students' environmental attitude: Scale development and validation. *International Journal of Educational Sciences*, *5*(4), 415–424. https://doi.org/10 .1080/09751122.2013.11890103

VILBERT, J. J. (2021). Global Governance and the WHO's Mandate Post-COVID-19 Crisis.

VIDERGOR, H. E., & KRUPNIK-GOTTLIEB, M. (2015). High order thinking, problem based and project based learning in blended learning environments. In Applied Practice for Educators of Gifted and Able Learners (pp. 217–232). https://doi.org/10.1007/978-946300-004-8_11.

Wu, F.; Zhao, S., Yu, B., Chen, Y.M., Wang, W., Song, Z.G., Hu, Y., Tao, Z.W., Tian, J.H., Pei, Y. (2020). A new coronavirus associated with human respiratory disease in China. Nature, 579, 265–269.

Y. MA, Y. ZHAO, J. LIU, X. HE, B. WANG, S. FU, J. YAN, J. NIU, J. ZHOU, B. LUO (2020). Effects of temperature variation and humidity on the death of COVID-19 in Wuhan, China