International Journal of Agricultural and Applied Sciences, June 2023, 4(1): 132-138
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2023.4122

Review Article

OPEN ACCESS

The potentiality of GIS for assessing soil pollution – A review

Ali R. A. Moursy, Osama K. A. Abdelhamid, and Jihad M. A. Abd-Elmajid
Soil and Water Department, Faculty of agriculture, Sohag University, Sohag, 82524, Egypt
**Corresponding author e-mail: ali.refaat@agr.sohag.edu.eg*
(**Received:** 20/02/2023; **Revised:** 14/05/2023; **Accepted:** 26/06/2023)

ABSTRACT

The assessment of soil pollution is only one instance where geographic information systems (GIS) have shown to be an invaluable tool in environmental management and assessment. Globally, there is growing worry over soil pollution since it can have catastrophic repercussions on plant, animal, and human life. A more in-depth understanding of the scope and severity of contamination is made possible by GIS, which offers a flexible and all-encompassing method to studying and assessing soil pollution. With the aid of GIS technology, precise maps of soil contamination may be produced by combining data from numerous sources, such as remote sensing, aerial photography, and ground surveys. This information can then be evaluated using a variety of techniques, such as spatial analysis, to pinpoint polluted areas, possible sources of pollution, and the effects they are most likely to have on the environment and human health. By making it easier to identify sensitive regions that need additional research or remediation, GIS can also help with the analysis of the risk of pollutant movement and dispersion. Comparing GIS to conventional methods for assessing soil pollution has various benefits. First of all, it enables a more thorough and in-depth examination of the degree and breadth of contamination, enabling the identification of locations that need urgent care. Second, it makes it easier for different stakeholders, such as environmental agencies, researchers, and policymakers, to share data and information, enabling better decision-making. Thirdly, it makes it possible to monitor and control soil contamination more effectively, allowing for the early detection of potential issues and the implementation of suitable corrective actions. In general, GIS technology is a useful tool for assessing soil pollution since it offers a more thorough and knowledgeable approach to environmental management. It is a crucial tool for environmental experts engaged in the assessment and control of soil pollution due to its capacity to combine different data sources, perform spatial analysis, and promote information sharing.
Keywords: GIS, soil pollution, contaminants, risk assessment, mapping.

INTRODUCTION

For organizing and evaluating data about soil pollution, geographic information systems (GIS) are a crucial tool. Environmental agencies are gathering a growing amount of data, and GIS can assist in organizing and visualizing this data to make it simpler to interpret and use in decision-making (Kamariddinovich and Rakhimjonovna 2023). In this post, we'll look at how GIS is used to manage soil pollution and explore some of its practical uses. A severe problem that affects both the environment and human health is soil pollution. It happens when pollutants are dispersed into the soil by either natural or artificial methods. Industrial operations, agricultural practices, and waste disposal facilities are just a few of the sources that might produce contaminants. Heavy metals, pesticides, herbicides, and other chemicals that may be hazardous to human health as well as to plant and animal life can be included (Gautam et al., 2023). Data about soil pollution are manipulated and estimated in several ways using GIS. The mapping of soil pollution is one of the most significant uses of GIS. For environmental authorities and decision-makers, GIS can help to provide detailed maps of the scope and severity of soil pollution. Environmental agencies can quickly and readily identify locations that need additional research or cleanup by producing maps that show soil pollution data (Neeraj et al., 2023). Data on soil pollution can also be examined using GIS. GIS can assist in identifying patterns and trends in soil contamination by combining data from many sources, such as soil samples, water quality data, and land use information. As a result, environmental agencies may be better able to comprehend the origins and consequences of soil pollution and create preventative and corrective measures (Abuzaid et al., 2023). Risk assessment is a significant GIS application in soil pollution management. GIS can help to identify places and populations that are at risk from soil contamination by fusing data on soil pollution with details on the susceptibility of various ecosystems and groups. As a result, decision-makers may be better able to focus resources where they are most required and prioritize remedial activities (Jin et al., 2023). One of GIS's most potent features is its capacity to combine data from numerous sources. GIS can present a thorough picture of soil contamination in a specific area by combining data from soil samples, water quality assessments, land use data, and other sources. Taking into consideration a variety of elements and variables, this can assist environmental agencies in making judgments about how to control and remediate soil pollution (Liu et al., 2023). Additionally, the transport and dispersion of pollutants in soil can be modeled using GIS. GIS can mimic the spatial distribution of soil contamination and soil contaminants by utilizing computer modeling approaches (Patel et al., 2023).

The main objective of this article is to overview the potentiality of GIS in assessing soil pollution.

Soil pollution

Due to the rise in soil contamination over the past few decades, both human and environmental health may be at danger. The main causes of soil pollution are human activities, which cause contaminants to accumulate in soils to potentially dangerous levels. Soil pollutants include a wide range of contaminants (both organic and inorganic substances) that are either created as a result of anthropogenic activity or are naturally present in soil. Monitoring soil quality may be difficult due to the absence of definite monitoring indicators and parameters. On the other hand, issues related to the expansion of the world's population are continuously putting pressure on soil quality and the necessity of long-term soil fertility. Soil contamination has become a prominent topic due to the intersection of all the aforementioned issues (Cachada et al., 2018). Soil is considered as the pillar of the agricultural ecosystem and significant store for organic materials which able to absorb the dangerous components (Anawar and Chowdhury 2020). The decrease in soil productivity brought on by the presence of pollutants in the soil is known as soil pollution. As stated by Weissmannová and Pavlovsk (2017), it might also be a persistent problem for agricultural usage that is influenced by the safety of the food and water ingested. Heavy metal poisoning of soil is an issue for food chains and public health, particularly in mining zones. Numerous studies centered on evaluating the risk of soil pollution and its spread from mining regions to the surroundings as well as employing supplemental data to map soil heavy metals (Zeng et al., 2021). Soil contamination is the presence of some compounds in soil as a result of human activities. These contaminants can harm fundamental soil structures, decrease soil quality, and have a negative impact on the health of both people and the environment. Many nations have identified soil contamination as a major national concern on how it impacts agricultural land and people's health (Luo et al., 2015). For instance, there are several events and protocols were established and created which have specific provisions acknowledging the significance of soil contamination and degradation in Asia today (MEP-PRC, 2016). Similar to other countries, the main heavy metals' sources in the world's include urbanization, transportation, waste disposal, industrial activity, power generation, agriculture, including fertilization and animal feeding additions, and mining as well as smelting. There are some locations with significant levels of soil contamination near point sources, such as mines and smelters, which raises serious but primarily limited concerns. Despite having lower contamination levels than other situations, including agricultural soils, they are nonetheless important as a direct channel for contaminating food (Zhou et al., 2014). Another example of a relatively small nation is the UK, which has a very diversified geology, heavy metal mineralization in certain regions, where a long-term mining activity cause soil pollution. Polluted areas have been addressed through the development planning process ever since the current soil system in the UK (Luo et al., 2009).

Types of soil pollution

Chemicals or other contaminants that are hazardous to living things can pollute soil. Pollutants harm the soil structure, lower its quality, and cause different types of the soil erosion. The pollution sources and its impact are utilized to differentiate between soil contamination types. The main types of soil contamination are such as the agricultural pollution, environmental wastes, and urban activities (Gautam et al., 2023).

Agricultural pollution

Through the application of fertilizers, agricultural operations improve crop yields but simultaneously polluting the soil and degrading its quality. By contaminating the soil, pesticides can affect plants and animals. These substances contaminate the groundwater supply by penetrating deeply into the soil. These pollutants collect in other places and damage the local water supply through irrigation and rain runoff. About 90% of contamination is caused due to the environmental wastes which inappropriate disposal causes the soil to become contaminated with dangerous chemicals that have an adverse impact on local flora and animal environment, water resources, as well as the fresh water. Chemicals found in toxic vapors from landfills have the potential to go back to the environment as the acidy rains which harm the appearance of agricultural soil (Yuan et al., 2023).

Pollution by the urban activities

Soil pollution can result from human activities both directly and indirectly. Inadequate drainage and increasing runoff cause nearby land areas or waterways to become contaminated. When waste is not properly decomposed, it accumulates in soil and cause pollution which can reach the groundwater. Bacteria are more effective soil microorganism which regenerated by the wastes' decomposition and produce methane and increase the global warming and negatively affect the air quality (Adedeji et al., 2019).

Soil pollution causes

Human activities affect the soil and lead to soil pollution. The pesticides and fertilizers are much linked to the soil pollution. Additionally, pesticide/s used on plants have the potential to penetrate into the ground and have a long-lasting impact. In turn, several potentially dangerous compounds present in plants may build up. Fertilizers, like cadmium, are used at amounts that are toxic and kill crops. By using contaminated water to irrigate crops or by using mineral fertilizers, heavy metals can penetrate the soil. Landfills, bursting underground bins, and sewage system leaks can all release toxins into the surrounding soil. Both natural and man-made processes can produce heavy metal contamination. Large discrepancies in mineral content among the surface layers of an organic soil and the lower horizons of the soil profile can result from natural processes such bioaccumulation in vegetation (Weber and Karczweska 2004). The acidy rain is considered as one of the most effective causes of the soil pollution. It is produced when industrial gases combine with precipitation on soil structure. Iron, steel, energy, and different chemicals manufacturing that carelessly treat the area as a wasteland leave enduring evidence for years to come. Vehicles that have been washed by rain may spill fuel, contaminating any nearby land. The soil erosion occurs when soil particles move by water as well as wind and cause lose in the soil structure and nutrients. Here are some soil pollution causes: (1) industrial liquid and solid wastes, such as toxic solutions, gases and also different chemicals; (2) Solid and liquid agricultural materials such as pesticides, insecticides and fertilizers; (3) poor system of the soil management; (4) improper techniques of irrigation; (5) the frequent and continuous leakage of sanitary waste; (6) toxic fumes from industries mix with rain to cause acid rain; (7) fuel spills are washed out of cars by precipitation and aeration; (9) The use of pesticides in agriculture keeps chemicals in the environment for long time; (10) the lack of a proper garbage disposal system causes garbage to spread into the soil; and (11) the improper disposal of nuclear waste contaminates the soil and has the potential to cause mutations (Woejko et al., 2020).

The impacts of soil pollution

Because of contacting with the polluted soils either directly or indirectly, human health as well as the ecological equilibrium are affected. Moreover, soil pollution impacts are dangerous on Earth's creatures. Infected soil frequently prevents crops from growing and thriving. Any cultivated crop in the contaminated soils can absorb harmful chemicals which provide a health risk to anyone who consumes them (Qin et al., 2021). Increased soil salinity can be a symptom of several types of soil contamination. The soil becomes unfit for plants in this circumstance and frequently turns useless and arid. Earthworms as important soil organism can perish where soil pollution alters the soil's structure. Besides the ability to enhance creatures' life, soil contamination can also change the structure of the soil, which can have an impact on large predators like birds (Pathan et al., 2020). The intake of foods cultivated in polluted soil causes health concerns, which has serious repercussions for human health. The genetic make-up of the body is altered by prolonged contact to contaminated soil, which increases the risk of prenatal disorders and chronic health problems. Heavy metals, gasoline, solvents, and agricultural chemicals can all cause cancer after prolonged exposure. Organophosphates have the potential to set off a series of events that result in neuromuscular obstruction. In their study, Mishra et al. (2016) concentrated on determining how pollution affects plant development. They noted that (1) the balance of the ecosystem is impacted by soil pollution; (2) Plants frequently cannot adapt to a change in soil chemistry in a short period of time; (3) Microorganisms present in the soil deteriorate and cause additional soil erosion problems; (4) soil pollution negatively affects the soil fertility and suitability for cultivation; (5) Polluted land cannot support the majority of life forms that depend on soil fertility; (6) Fruits and vegetables grown in polluted soil lack essential nutrients. They may be poisonous and cause serious health issues for those who consume them; (7) landfill emissions of poisonous gases and unpleasant odors negatively affects the human health as well as the surrounding environment; (8) death of several affected organisms such as earthworms may be due to the soil pollution whereas this phenomenon makes other predators affect the soil environment. Hou and Li (2017) noted that there are complexity and variability in the soil pollutants. This is due to the contributions from parent material and other anthropogenic activities like agricultural as well as atmospheric inputs.

Geographic Information System (GIS)

It is a computerized software/program which can stores, controls, examines, as well as presents spatial information. The professionals in several science fields use and rely on GIS since the 1970s. Additionally, GIS is an essential tool which can be used for normal operations in governmental and non-governmental organizations. Several services which depend on the spatial information as well as the location-based data such as the web mapping and in-vehicle navigation are perfect examples of using not only GIS but also other integrated tools such as the Internet, GPS and wireless technology.

The USD of Labor has assigned the GIS technologies as a sector with strong growth potential (Chang, 2008). There are numerous definitions for geographic information as well as the processes which utilized in storing, retrieving and displaying the spatial as well as the geographic information. In this article, general definition is provided which based mainly on the developed information system to manage different types of the data resources in several fields of application and utilization as well as research (Goodchild, 2018). A geographic information system is an integration of modern technology and tools including software, hardware, information/data, people/users, and organizations/institutional frameworks. The GIS is used to collect, store, analyze, and disseminate information on geographical areas of the planet (Ali, 2020).

GIS Components

Like other information technologies, a GIS needs certain components in order to function. A GIS is made up of five fundamental components: technology, software, data, people, and methodologies.

Hardware/Equipment

Computers are used for data processing, storage, input, as well as output, product or service. Several hardware facilities such as the printers and plotters are utilized to produce the output reports and maps. In addition, the different kinds of the digitizers, scanners, and photocells can be used to rectify and digitize the spatial information. The GPS instrument' data as well as the mobile devices are utilized for the field work.

Software/Programming

GIS software, whether it is open source or commercial, consists of computer programs and applications that are used to manage data, perform data analysis, display data, and perform other functions. GIS can leverage additional programs created in C++, VB.NET, JavaScript, or Python for particular data analytics. Menus, icons, and command lines are often used user interfaces for these programs and apps while running on an operating system like Windows, Mac, or Linux.

Data

The several types of the data are very important component of a GIS. A GIS use the database management system (DBMS), which is applied in many organizations in order to organize and preserve the information/data. The main two types of the geographic data which can be used in the GIS are vector and raster data. These types of data are considered as data layers in the GIS work environment which can be presented as points, lines, and polygons.

Users/People

GIS experts determine the goals of using GIS, interpret the data, and communicate the findings. GIS tools cannot be used without the users who manage, use and develop the applied methods to solve the different issues. Users of GIS include those who use it to facilitate their daily work as well as the technical professionals who developed and maintain the system. End-users are persons who use the GIS tools to achieve the aim of the organization or a specific project/program.

Methods

An effective GIS adheres to several kinds of plans and businesses, which are considered as components of frameworks and model-specific activities. A methodical way to measure a variety of geographical activities and events is the geographic information system. To highlight geographical themes, entities, and relationships, use a computer database to represent these measurements. By merging several sources, use these representations to create more measures and discover fresh relationships. These representations should be altered to work with other sets of relationships and entity systems. The institutional and cultural context in which these people operate is reflected in their actions. GIS is essentially a collection of computer programs for organizing data geographically. The fact that it may combine ideas and procedures from other fields, such as mapping, geography, surveying, statistics, and operation research approaches, as well as mathematical and statistical processes which makes it more flexible for managing the spatial and geographic information. By creating a direct relationship of the spatial and non-spatial kinds of information, it is able to conduct an integrated analysis. Spatial data, which are essentially mapped databases, includes charts, aerial photos, satellite images, maps that have been surveyed from a plane table, and observations from the Global Positioning System (GPS). The attribute or non-spatial data can be discovered as words, numbers, or symbols in secondary surveys, the census, and other sources. Moreover, the maps are generated using different methods and GIS tools which can be utilized in different projects. Either manually utilizing the scanned images or automatically using a raster to vector creator can create the map. These digital maps could be produced by any survey company or derived from satellite photos (Ali, 2020).

Organization

Operations involving GIS take place in an organizational setting. As a result, people need to be included in the organization's culture and decision-making processes when it comes to things like role and value (Chang, 2008).

The Role of GIS in assessing soil pollution

Recent developments in digital technologies have increased the number of applications and the growth of GIS, which has profited from GIS as an important partner technology for the evaluation of crops, soils, and their habitats. In recent decades, the application of GIS in agriculture has expanded significantly. The entire agricultural value chain makes use of GIS. To characterize different kinds of factors affecting a specific phenomenon, the researchers use several GIS tools and features. There are many soil applications can be done using GIS such as spatial variability distribution of different soil properties such as texture, groundwater table, fertility, pollution, hydraulic conductivity, slope, electrical conductivity, climatic conditions, topography, land use/land cover, biotic and abiotic stresses, and etc. In order to increase agricultural productivity and profitability through accurate techniques, it is increasingly important to provide the necessary spatial and geographic data (Shan et al., 2013). Environmental and public health data can considerably benefit from GIS (Tim, 1995). An important consideration is the relationship between geographic and descriptive information. Consider a set of spatial data represent several areas or cities which can be connected by a table, include area's name, its population, etc. These systems provide details on the data related to the location where it is gathered, managed, stored, processed, and visualized in a digital setting. This information are commonly known as cartographic, geographic, or spatial data. They might also be related to a variety of characteristics that characterize them as unique (Fradelos et al., 2014). Through continuous progress, GIS has considerably expanded geographic research and applications over the past 50 years, and has advantages for other subjects like Earth System (Goodchild, 2018). Gathering geographic data, identifying and characterizing the earth objects are the main goals of GIS (Lin et al. 2013). This helps to explain why GIS has become more and more popular in contemporary society (Goodchild and Glennon 2008). By providing users with a logical framework for understanding spatiotemporal distributions and interactions, the geographical analysis integrated with other tools and data sources such as the statistical analysis' tools and the spatial data has made the applications of the GIS expanded far from the initial domain of mapping. GIS is used for identifying either physical or social dynamic spatial phenomena globally (Kosiba and Bauer 2013). However, not all phenomena or objects can be identified using the tools of GIS (Lü et al., 2019). All human activities are connected to the GIS applications. The online nautical maps encourage secure canal navigation by using routing and scheduling. Additionally, surveying is the process of locating an object on the earth's surface. Calculating angles and distances between various points on the surface of the earth is a necessary step in a land survey. Geologists utilize GIS for a wide range of objectives, but there are many other applications for it in the science. analyzing seismic data, investigating soils and strata, assessing geologic features, or creating three-dimensional (3D) visualizations of geographic features. Planning as well as social development employ GIS, and the GIS helps to distinguish the world challenges. Today's GIS technology is rapidly evolving and providing a wide range of new planning possibilities. In order to achieve sustainable tourism development, the GIS is also used in the tourist information system. The detection, risk assessment, and early warning of global earthquakes are all potential functions of the GIS. Additionally, GIS is utilized for fisheries and ocean industries, the development of public infrastructure facilities, and energy consumption tracking and planning. GIS helps managers organize and spatially visualize space to decide how it should be used. All agricultural activities make extensive use of GIS tools. GIS may be very helpful in evaluating soil capability, productivity, appropriateness, and fertility as well as mapping all soil properties and issues thanks to its data processing and transfer capabilities. According to Rathinavel et al. (2023), the GIS is also utilized for pesticide administration, crop protection, and the detection of biotic and abiotic stressors on plants. Information management will be crucial to improving farming methods in the upcoming decades. It makes logical to arrange farm information in spatial databases since agricultural processes are fundamentally geographical. Patchiness in the presence and dispersion of plant pathogens and disease is typical due to the geographical variability brought on by the biological and physical characteristics of agricultural systems. Plant disease management techniques can be improved by employing GIS to provide epidemiological data in the same way as other farm data (Fischer et al., 2019). In another study, the GIS tools were used to identify, detect, measure, analyze, and map incidents of environmental injustice, which is the related to environmental threats (Maantay, 2002). Additionally, the GIS used to evaluate the spatial variability of some hazards' sources (Brtnick et al., 2020). The detection of soil issues is proven to be successful with the integration of GIS and remote sensing (Iu et al., 2020). Due to the fast-industrial expansion and urbanization, toxic metals affect the agricultural soil poses a serious danger to both public health and ecological safety. Numerous studies have been conducted in this area. For instance, Bhuiyan et al. (2021) evaluated heavy metal deposition, spatial enrichment, environmental risk, and source allocation in certain soils of Bangladesh using a GIS. More than 90% of these soils exhibited higher concentrations of Cr and Cd. Similar to this, several investigations confirmed the contamination in various areas of Bangladesh due to excessive content of toxic metals in the water and rivers' sediments as well as some different industrial areas. In order to investigate the spatial variability of the heavy metals (Mn, Fe, Zn, and Cu) in various soils of Iran and identify soil pollution hotspots, Keshavarzi et al. (2022) employed GIS methodologies employing geo-statistical interpolation methods. El-Rawy et al. (2020) calculated the heavy metal concentrations to assess the risk of soil pollution in Egypt's Minya Governorate. They gathered 159 soil samples for that purpose, which were tested for the content of Mn, Zn, Cu, Fe, and B. While measuring the hazardous (As, Cd, Co, Ni, Se, and Pb) and heavy metal elements in the collected samples, the applicable pollution indicator was utilized. Geostatistical techniques were employed to identify the sources and concentration hotspots of the heavy metals deposited in the examined soil.

CONCLUSIONS

Finally, it should be noted that Geographic Information Systems (GIS) are essential for evaluating soil pollution. They offer a useful resource for gathering, processing, and visualizing geographic information about soil contamination. GIS enables researchers and stakeholders to acquire a thorough picture of the quantity and distribution of soil pollution by integrating diverse data sources, such as soil sampling data, land use data, and environmental monitoring data. Researchers can use GIS to produce intricate maps and models that show hotspots of soil contamination, pinpoint potential sources of pollution, and evaluate the dangers of polluted soil. Decision-makers can use this geographical analysis to build regulatory frameworks, prioritize locations for cleanup operations, and assess how well environmental management policies are working. The collaboration and information exchange between various stakeholders, such as scientists, policymakers, and communities, is also made easier by GIS. This improves the openness and accountability of assessments of soil pollution, enabling more informed decision-making and public participation in environmental management. It's crucial to recognize the GIS's limits when evaluating soil pollution, though. The quality of the input data, the availability of field verification, and the choice of the best analytical techniques all have a significant impact on the accuracy and dependability of the results. To enable thorough and accurate soil contamination evaluations, GIS must be integrated with other scientific methods and knowledge. In conclusion, GIS is a useful tool for evaluating soil pollution because it gives users a spatially explicit understanding of contamination patterns, directs decision-making, and promotes efficient cooperation among stakeholders. The ability to control and mitigate the effects of soil contamination on human and environmental health will continue to improve with continued improvements in GIS technology and data collection methods.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

REFERENCES

Abuzaid, A. S., Jahin, H. S., Shokr, M. S., El Baroudy, A. A., Mohamed, E. S., Rebouh, N. Y., & Bassouny, M. A. 2023. A Novel Regional-Scale Assessment of Soil Metal Pollution in Arid Agroecosystems. *Agronomy*, **13**(1), 161.

Adedeji, O. H., Olayinka, O. O., & Tope-Ajayi, O. O. 2019. Spatial distribution and health risk assessment of soil pollution by heavy metals in Ijebu-Ode, Nigeria. *Journal of Health and Pollution*, 922.

Ali, E. 2020. Geographic information system (GIS): definition, development, applications & components. Department of Geography, Ananda Chandra College. India.

Anawar, H. and Chowdhury, R. 2020. Remediation of Polluted River Water by Biological, Chemical, Ecological and Engineering Processes. *Sustainability*, **12**, 7017.

Bhuiyan, M. A. H., Karmaker, S. C., Bodrud-Doza, M., Rakib, M. A., & Saha, B. B. 2021. Enrichment, sources and ecological risk mapping of heavy metals in agricultural soils of dhaka district employing SOM, PMF and GIS methods. *Chemosphere*, **263**, 128339.

Brtnický, M.; Pecina, V.; Baltazár, T.; Vašinová Galiová, M.; Baláková, L.; Bęś, A.; Radziemska, M. 2020. Environmental Impact Assessment of potentially toxic elements in Soils Near the Runway at the International Airport in Central Europe. *Sustainability* 12, 7224.

Cachada, Anabela, Teresa Rocha-Santos, and Armando C. 2018.Duarte. "Soil and pollution: an introduction to the main issues." Soil pollution. Academic Press, 1-28.

Chang, K. T. 2008. Introduction to geographic information systems (Vol. 4. Boston: Mcgraw-hill).

El-Rawy, Mustafa, Abdelrahman, M. A., & Ismail, E. 2020. Integrateduse of Pollution in dices and geo maticsto Assess Soil Contamination and identify Soil Pollution Source in El-Minia Governorate, Upper Egypt. *Journal of Engineering Science and Technology*, **15**(4), 2223-2238.

Fischer, M. M., Scholten, H. J., & Unwin, D. 2019. Geographic information systems, spatial data analysis and spatial modelling: an introduction. In Spatial analytical perspectives on GIS (pp. 3-20. Routledge).

Fradelos, E. C., Papathanasiou, I. V., Mitsi, D., Tsaras, K., Kleisiaris, C. F., & Kourkouta, L. 2014. Health based geographic information systems (GIS) and their applications. *Acta Informatica Medica*, **22**(6), 402.

Gautam, K., Sharma, P., Dwivedi, S., Singh, A., Gaur, V. K., Varjani, S., ... & Ngo, H. H. 2023. A review on control and abatement of soil pollution by heavy metals: Emphasis on artificial intelligence in recovery of contaminated soil. *Environmental Research*, 115592.

Goodchild, M.F. and Glennon, A., 2008. Representation and computation of geographic dynamics. In: K.S. Hornsby and M. Yuan, eds. Understanding dynamics of geographic domains. Boca Raton: CRC Press, 13–28.

Goodchild, M.F., 2018. Reimagining the history of GIS. *Annals of GIS*, **24** (1), 1–8.

Hou, D.; Li, F. 2017.Complexities surrounding China's soil action plan. *Land Degrad*. **28**, 2315–2320.

Iu, H.; Yang, R.; Zhou, Z.; Huang, D. 2020. Regional Green Eco-Efficiency in China: Considering Energy Saving, Pollution Treatment, and External Environmental Heterogeneity. *Sustainability* **12**, 7059.

Jin, H., Zhihong, P., Jiaqing, Z., Chuxuan, L., Lu, T., Jun, J., ... & Shengguo, X. 2023. Source apportionment and quantitative risk assessment of heavy metals at an abandoned zinc smelting site based on GIS and PMF models. *Journal of Environmental Management*, **336**, 117565.

Kamariddinovich, O. R., & Rakhimjonovna, K. K. 2023. Improving Methods for Mapping Irrigation Networks Using GIS Technologies. *Finland International Scientific Journal of Education, Social Science & Humanities*, **11**(4), 691-699.

Keshavarzi, A., Bhunia, G. S., Shit, P. K., Ertunç, G., & Zeraatpisheh, M. 2022. Spatial Pattern Analysis and Identifying Soil Pollution Hotspots Using

Local Moran's I and GIS at a Regional Scale in Northeast of Iran. In Soil Health and Environmental Sustainability: Application of Geospatial Technology (pp. 283-307. Cham: Springer International Publishing.

Kosiba, S. and Bauer, A.M. 2013. Mapping the political landscape: toward a GIS analysis of environmental and social difference. *Journal of Archaeological Method and Theory*, **20** (1), 61–101.

Lee, C. S. L., Li, X., Shi, W., Cheung, S. C. N., & Thornton, I. 2006. Metal contamination in urban, suburban, and country park soils of Hong Kong: a study based on GIS and multivariate statistics. *Science of the Total Environment*, **356**(1-3), 45-61.

Lin, H., Chen, M., Lu, G., Zhu, Q., Gong, J., You, X., ... & Hu, M. 2013. Virtual geographic environments (VGEs): A new generation of geographic analysis tool. *Earth-Science Reviews*, **126**, 74-84.

Liu, J., Kang, H., Tao, W., Li, H., He, D., Ma, L., ... & Li, X. 2023. A spatial distribution–Principal component analysis (SD-PCA) model to assess pollution of heavy metals in soil. *Science of The Total Environment*, **859**, 160112.

Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A. X., & Chen, M. 2019. Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective. *International journal of geographical information science*, **332**, 346-367.

Luo, Q., Catney, P., Lerner, D., 2009. Risk-based management of contaminated land in the UK: Lessons for China? *J. Environ. Manage*. **90**, 1123-1134.

Maantay, J. 2002. Mapping environmental injustices: pitfalls and potential of geographic information systems in assessing environmental health and equity. *Environmental health perspectives*, **110**(suppl 2), 161-171.

MEP-PRC, 2016. Ministry of Environmental Protection Detailed "soil ten": resolutely declared war on pollution: Ministry of Environmental Protection of of the People's Republic of China.

Mishra, R. K., Mohammad, N., & Roychoudhury, N. 2016. Soil pollution: Causes, effects and control. *Van Sangyan*, **3**(1), 1-14.

Neeraj, A., Hiranmai, R. Y., & Iqbal, K. 2023. Comprehensive assessment of pollution indices, sources apportionment and ecological risk mapping of heavy metals in agricultural soils of Raebareli District, Uttar Pradesh, India, employing a GIS approach. *Land Degradation & Development*, **34**(1), 173-195.

Patel, P., Mehta, D. J., & Sharma, N. D. 2023. A GIS-based DRASTIC Model for Assessing Groundwater Quality Vulnerability: Case Study of Surat and its Surroundings. *Journal of the Geological Society of India*, **99**(4), 578-582.

Pathan, S. I., Arfaioli, P., Bardelli, T., Ceccherini, M. T., Nannipieri, P., & Pietramellara, G. 2020. Soil pollution from micro-and nanoplastic debris: A hidden and unknown biohazard. *Sustainability*, **12**(18), 7255.

Qin, G., Niu, Z., Yu, J., Li, Z., Ma, J., & Xiang, P. 2021. Soil heavy metal pollution and food safety in China: Effects, sources and removing technology. *Chemosphere*, **267**, 129205.

Shan, Y., Tysklind, M., Hao, F., Ouyang, W., Chen, S., & Lin, C. 2013. Identification of sources of heavy metals in agricultural soils using multivariate analysis and GIS. *Journal of Soils and Sediments*, **13**, 720-729.

Tim, U.S. 1995. The application of GIS in environmental health sciences: opportunities and limitations. *Environ Res* **71**:75–88.

Weber, J. and Karczewska, A. 2004. Biogeochemical processes and the role of heavy metals in the soil environment. *Geoderma*, **122**, 105–107.

Weissmannová, H. D. and Pavlovský, J. 2017. Indices of soil contamination by heavy metals–methodology of calculation for pollution assessment. *environmental monitoring and assessment*, **189**(12), 616.

Wołejko, E., Jabłońska-Trypuć, A., Wydro, U., Butarewicz, A., & Łozowicka, B. 2020. Soil biological activity as an indicator of soil pollution with pesticides–a review. *Applied Soil Ecology*, **147**, 103356.

Yuan, R., Xu, C., & Kong, F. 2023. Decoupling agriculture pollution and carbon reduction from economic growth in the Yangtze River Delta, China. *PloS one*, **18**(1), e0280268.

Zeng, L., Wang, Y., Jing, L., & Cheng, Q. 2021. Quantitative determination of auxiliary information for mapping soil heavy metals and soil contamination risk assessment. *Applied Geochemistry*, **130**, 104964.

Zhou, X., Zheng, L., Hu, K., 2014. Sources and hazards of polluted soil. *J. of Wuhan Inst. of Tech*. **36**, 12-19.

Citation: Ali R. A. Moursy, Osama K. A. Abdelhamid, and Jihad M. A. Abd-Elmajid 2023. The potentiality of GIS for assessing soil pollution – A review. *International Journal of Agricultural and Applied Sciences*, 4(1):132-138. https://doi.org/10.52804/ijaas2023.4122