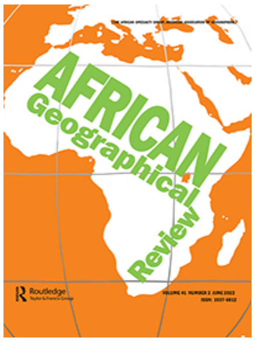

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Risk-based contaminated land management policy mindset: A way out for Ghana's environmental challenges

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ABSTRACT

Ghana lacks an environmental policy on contaminated land. This commentary aims at suggesting a proactive risk-based contaminated land management policy by presenting precedents of land contamination and environmental disasters from developed jurisdictions and how lessons learned improved environmental regulation. In Ghana, however, when contamination and environmental disasters happen, they are hardly investigated, and even if investigated, recommendations are not implemented. Then, a summary of the United Kingdom's Contaminated Land Policy framework is presented and it is demonstrated that Ghana has the professionals to implement the policy. Recommendations are presented for future implementation of a contaminated land policy in Ghana.

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Ghana; risk-based contaminated land management; sustainable development; Ghana Environment Protection Agency; site conceptual model

Introduction: effects of rapid urbanization and the unavailability of a risk-based contaminated land management policy

In the past three decades, Ghana, just like other developing countries, has experienced a high rate of urbanization, characterized by poor physical planning and development, peri-urban area expansion, and unavailability of land (Amoateng et al., 2013; Boamah et al., 2012; Cobbinah et al., 2015). These characterizations have resulted in developments on and near the former refuse dump and landfill sites, metal scrap yards (Figure 1), and old garages (Dowling et al., 2015). Governments in other jurisdictions like Europe and North America would consider the preceding sites as contaminated lands due to the nature of contaminants that may be on or under these sites regulate and control development

activities on such sites. This is because, in Ghana, there is no policy document that explicitly regulates contaminated land activity. Developments on such lands require that the lands are remediated and cleaned up or contaminants are demobilized from causing harm to sensitive receptors before development permits are granted. In Ghana, the Environmental Impact Assessment (EIA) of the Environmental Protection Agency (EPA) Act 490, 1994, Section 12, and the EPA Environmental Assessment Regulation 1999 are the regulations that come close to controlling development on contaminated land, but unlike the developed jurisdictions, they fail to provide a proactive, consistent, coherent, and structured approach on regulating contaminated land activity (Campion & Essel, 2013). The latter regulation also makes provisions for land

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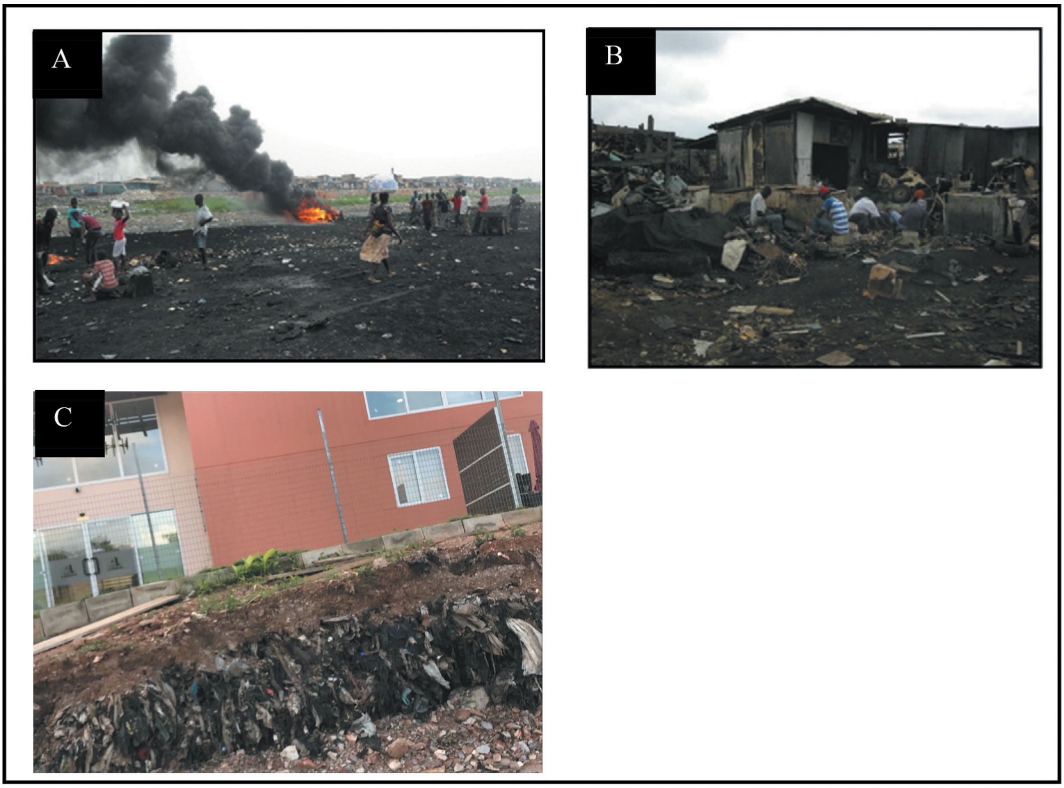

Figure 1. Developments on contaminated sites in Accra. Agblogloshie for A:Open burning of e-waste, with exposure to humans, from Oteng-Ababio (2012); B: Working environment of e-waste workers, from Asante et al. (2012); C:Estate development on the old Achimota Refuse Dump site showing refuse below the estate structure.

reclamation bond (via deposits of funds in a bank) that enjoins mining or other extractive companies to reclaim or remediate the land after mining or at the decommissioning stage of the mine project life cycle. Here only the well-established mining companies adhere to the reclamation (Tetteh et al., 2015) whereas the majority of the small artisanal miners leave the lands unreclaimed (Crawford et al., 2015; Hilson, 2001; Mensah et al., 2015). The current regulatory regime results in a reactive rather than a proactive approach in dealing with contaminated lands.

For Ghana to develop sustainably, this work identifies three (3) reasons why the country must develop a proactive, structured, objective, and transparent Risk-Based Contaminated Land Management Policy, that is hinged on risk assessment and evaluation approaches. In Europe and North America, the costs of clean-up and remediation, public perception, and fear of contaminated lands resulting from the legacy of contamination from previous industrial activity are well documented and have been a research area for the past four decades (Nathanail, 2009; Petts et al., 1997; Pollard et al., 2001). Despite the level of interest in contaminated land in these jurisdictions, it is usually difficult to establish a direct causative link between disease conditions in humans and suspected contaminated land sites. In these jurisdictions, lessons learned from the past legacies of contamination resulted in environmental regulation improvements that have sought to proactively identify and regulate the contaminated land activity. However, in Ghana, lessons learned from other developed jurisdictions and even locally have not been appreciated as the country contaminates its lands without effective environmental regulation of activity on such lands (Petts et al., 1997). Secondly, works by previous authors have highlighted the threats posed by contaminated sites to sensitive receptors. Kodom et al. (2012) showed that the soils of Suame Magazine, Kumasi, Ghana were contaminated by heavy metals (Cr, Cd, and Hg) from anthropogenic sources, with concentrations exceeding threshold limit values. In Agbogloshie, Accra, Ghana, Caravanos et al. (2011) found elevated levels of Fe, Cu, Al, Zn, and Pb concentrations in the breath zone of e-waste workers. In another study in Agbogbloshie, Asante et al. (2012) also found elevated Fe, Sb, and Pb concentrations in the urine of e-waste workers. Both studies in Agbogbloshie attributed the recorded concentrations to the vulnerability of the e-waste workers to heavy metals from mechanical shredding and open burning for metal extraction from the e-waste. Previous works, e.g., Armah and Gyeabour (2013) and Mensah et al. (2020), show that inhabitants of mining areas in the Ashanti and Western Regions are likely to be exposed to heavy metals resulting from mining activities. For the vulnerability of groundwater receptors to contamination from surface soils, Cuthbert and Tindimugaya (2010) and Sorensen et al. (2014) found in hydrogeological regimes, similar to Ghana's, that contaminants in recharge reached aquifers by preferential fracture flow without attenuation in the weathered regoliths.

Thirdly, due to rapid urbanization and land scarcity, buildings are constructed on areas that could be considered as contaminated lands. These developments have financial, insurance, and legal implications should contaminants be mobilized to reach sensitive receptors like structural foundations, humans, aquifers, flora, and fauna near, under, or on the land (Clarke, 1996; Lennon, 2001; Syms, 1996). However, these implications are not considered by government regulators, developers, professionals of the built environment, and project financiers during the conceptualization, development, and occupation of these dwellings because of the unavailability of a guide document on developments on contaminated land.

With the above reasons, this commentary suggests a policy framework for Ghana to identify and manage contaminated lands. We will demonstrate with some case precedents from other jurisdictions and Ghana about the legal, financial, environmental, and social threats posed by contaminated land and environmental disasters to the sustainable development ethos. The precedents are also presented to contrast the difference in approach after the occurrence of environmental disasters that a change of environmental mind-set, attitude, and stringent enforcement of legislation can solve the environmental challenges in Ghana. Then, a summary of the risk-based methodology will be presented, with the aim that Ghana adopts a prototype that is relevant to the economic and social setting of Ghana. Then, the human resource and professionals needed for implementing the methodology in Ghana is presented. Also, some challenges to the implementation of the policy are stated. Finally, some recommendations are presented for kick-starting the discussion for risk-based contaminated land management and its regulation in Ghana.

Example case precedents of contamination and environmental disasters in other jurisdictions and Ghana

Environmental disasters are well documented in developed jurisdictions. But for this commentary, however, four (4) case precedents will be discussed and these include Love Canal (LC), United States of America (USA), Loscoe Apartment explosion, United Kingdom (UK), Hinkley contamination, US, and Corby town contamination and suit, UK. The case precedents for Ghana include the Dimethoate spillage in Kumasi in 2012 and the 3 June 2015 flood and fire disaster in Accra.

Love Canal toxic contamination, New York, USA

The Love Canal is a rectangular, 16-acre 3-m deep landfill centered in a residential neighborhood in northwestern New York State (Gensburg et al., 2009; NYSDOH (New York State Department of Health), 2008; Petts et al., 1997). In the late 19th century, the Canal was originally dug by William Love to link up the upper and lower Niagara Rivers for the development of hydroelectric power. Between 1942 and 1953, Hoover Chemical and Plastics Corporation and others dumped about 21,800 tons of at least 200 different chemicals into the Canal (Banks, 2003; Gensburg et al., 2009). From the Hoover Company records, the majority of the chemicals dumped were hexachlorocyclohexanes (e.g., lindane); benzyl chlorides; organic sulfur compounds (e.g., lauryl mercaptans); chlorobenzenes; and sodium sulfide/sulfhydrates which are known to be carcinogenic (NYSDOH

(New York State Department of Health), 1978; Gensburg et al., 2009). In 1953, the waste was capped and the Canal was purchased by the Niagara Falls Board of Education, and the next year, an elementary school was built on the edge of the Canal with playing fields on the filled area. Around this time, residential house development had accelerated around the Love Canal (NYSDOH (New York State Department of Health), 1978; Petts et al., 1997). In 1978, the attention of the Federal Government was drawn to the site because heavy rains caused the migration of chemical leachate from the Canal to invade backyards and basements of surrounding properties. Thereafter, environmental sampling has begun, focussing on indoor air, soil, sediments, water, leachate, and biota, particularly in homes closest to the landfill (NYSDOH (New York State Department of Health), 1978; Gensburg et al., 2009). At the time of this incident, there were 97 resident families composed of 230 adults and 134 children immediately adjacent to the Canal (NYSDOH (New York State Department of Health), 1978). During the 1977–1978 school year, 410 students were enrolled at the school. In the early 1980s, state and federal emergency declarations led to an emergency funding for the purchase of residences in the larger neighborhood surrounding the landfill, known as the Emergency Declaration Area (EDA)(NYSDOH (New York State Department of Health), 2008; Gensburg et al., 2009). The incident also led to the promulgation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), known as Superfund. Superfund seeks to prevent the release of hazardous chemicals and ensures that toxic and contaminated sites are properly cleaned up (Banks, 2003; Nathanail, 2009; Petts et al., 1997). Later, epidemiological investigations on the inhabitants on blood level of semivolatiles (Bristol et al., 1982), cytogenetic abnormalities and sister chromatid exchange (Heath et al., 1984), nerve conduction velocity (Barron, 1982), rates of drug metabolism (Cuddy et al., 1984), cancer incidence (Janerich et al., 1981), cancer mortality rate (Gensburg et al., 2009), low birth weight (Goldman et al., 1985; Vianna & Polan, 1984), congenital malformations (Goldman et al., 1985), children's growth rates (Paigen et al., 1987), and problems in childhood development (Goldman et al., 1985) were inconclusive and contradictory. Despite the equivocal studies highlighted above, the Love Canal incident showed fear, the financial costs, and potential health risks of dumping industrial wastes and hazardous chemicals without state regulation (Banks, 2003; Petts et al., 1997).

Loscoe apartment explosion, UK

On 24 March 1986, there was an explosion in 51 Clarke Avenue, a bungalow adjacent to a capped landfill site in Derbyshire resulting in the complete destruction of the bungalow and causing severe injuries to its 3 occupants (Kibble & Saunders, 2001; Petts et al., 1997; Williams & Aitkenhead, 1991). The explosion was caused by the uncontrolled migration of landfill methane gas to the bungalow via permeable sandstone and fractured mudstones after a rapid drop of barometric pressure. The gas ignited on reaching the bungalow (Nathanail, 2013; Williams & Aitkenhead, 1991). Initially, the landfill site was not suspected, but investigations after the incident revealed the gas sample was similar to landfill gas of composition 60% CH_4 and 40% CO_2 (Williams & Aitkenhead, 1991). A landfill about 70 m away was initially fingered, and further geological/ground investigation showed gas migration pathway to the building basement was via permeable sandstones and fractured mudstones underlying the site (Williams & Aitkenhead, 1991). The landfill site had been worked as a clay pit for bricks during the 19th century. In 1973 when buildings developed around the pit, the pit was licensed to be filled with inert waste but was later permitted to be filled with about 50–100 tonnes of domestic and putrescible waste per day. In 1982, the landfill was capped with clay. A few months prior to the explosion, there was ground heating that caused distress and wilting in grass and plants in backyards. But during investigations of the occurrence, the landfill was not suspected because of an inappropriate geological model and unappreciation of the migration pathways of methane, resulting in suspicion of coal underlying the area. Had the geology and hydrogeology of the site been appreciated, the explosion could have been forestalled or mitigated. This incident resulted in the promulgation of legislation for the siting, design, construction, and decommissioning of landfill sites in the UK (Nathanail, 2013; Petts et al., 1997; Williams & Aitkenhead, 1991) and highlighting the importance of risk assessment and geological and hydrogeological conceptual modeling for landfill projects planning and execution.

Hinkley contamination and regulation of Cr^{+6}

This groundwater contamination by Cr^{+6} and the effects of the contamination were highlighted in the 2000 movie Erin Brokovich, which won Julia Roberts an Oscars and other awards (Banks, 2003). Hinkley is a small town in California, home to Pacific Gas and Electricity Company (PG & E), which is one of the biggest utility companies in the world. PG & E constructed the Hinkley Compressor Towers as part of its pipeline system, which carries natural gas from Texas to California, supplying heating and power plants (Banks, 2003; Pellerin & Booker, 2000). Because of the loss of head during transport, the compressor towers served to re-pressure the gas for transmission (Banks, 2003). To prevent rust in the towers, Cr^{+6}, which is a rust inhibitor was used in the tower, whilst cooling of the tower was done by oil and water. Cr^{+6} is known to be genotoxic and carcinogenic (Izbicki & Groover, 2019; Pellerin & Booker, 2000; Wright et al., 2015). PG & E discharged about 370million gallons of tower effluent containing Cr^{+6} into open unlined ponds in the Hinkley area (Izbicki & Groover, 2019; Pellerin & Booker, 2000). The discharged effluent contaminated the aquifer supplying the town of Hinkley, with recorded Cr^{+6} concentrations higher than generic acceptable limits for drinking water (Izbicki & Groover, 2019).

In 1993, 650 complainants brought a suit against PG & E (Anderson vs PG & E). The plaintiffs claimed there was a causative link between their ailments (prostate, cervical, and breast cancers and stomach disorders and miscarriages) and the groundwater contamination from Cr^{+6} because of the companies' discharge activities in the past (Banks, 2003; Pellerin & Booker, 2000). They accused the company of knowing about the contamination but failing to inform residents. Eventually, the company withdrew the case from the court for a settlement via mediation. In 1996, PG & E agreed to pay US$ 333 million to the complainants, agreed to stop using Cr^{+6} in their towers, and also to clean up the aquifer. Despite the controversy surrounding the epidemiology of cancer and its link with Cr^{+6} (Pellerin & Booker, 2000), and the difficulty of drawing of a link between the contaminant and the ailments in Hinkley, the settlement is the largest settlement of a direct-action lawsuit in the US and environmental litigation case. The case drew the attention of non-specialists, legislators, regulators, geoscientists, and toxicologists about the potential threats of Cr^{+6} on human health and the need to strictly regulate total Cr and Cr^{+6} in industrial releases (Banks, 2003; Nathanail, 2009).

Corby town contamination case and suit, UK

Compared to the previous case precedents, the Corby case has not been continuously studied and so most of the details of this contamination are extracted from the court ruling. This decision is detailed in the England and Wales High Court (Technology and Construction) Decisions (2009), (http://www.bailii.org/ew/cases/EWHC/TCC/2009/1944.html).

In 2009, the judgment on the Corby town contamination case made legal and environmental history in the UK. The suit involved the suing of Corby Council by 18 families of Corby town. The plaintiffs accused the defendants of causing birth defects in children from the improper and unprofessional remediation of an old British steel site in the town. Between a 15-year period (1984–1999), the Corby Council dug up and transported about 2,000,000 m^3 soils contaminated with dioxins, polycyclic aromatic hydrocarbons (PAHs), and heavy metals (Cd, Pb, and Cr) from the old steel site to a nearby quarry site. However, the transportation was done through the Corby town with un-sheeted vehicles. The plaintiffs claimed the remediation activity left sludge on the roadways and released large amounts of dust particles into the air. According to the plaintiffs, between the late 1980s and 1990s, residents had deformities 3 times higher than the surrounding towns. They also claimed that the babies with deformities were found to be from families without a history of birth defects. According to the claimants, their deformities including missing or underdeveloped fingers and feet were caused by inhalation and ingestion of contaminants by their pregnant mothers during the transportation and remediation exercise, resulting in deformities affecting the fetuses in the womb. In 2009, after 10 years of trial, Corby Council was found negligent and 'liable public nuisance in causing, allowing or permitting the dispersal of dangerous and noxious contaminants in particular Cadmium, Chromium, Nickel, PaHs and dioxins'. The Council was also found liable for the breach of the UK Environment Protection Act 1990 statutory rules for the reclamation of the Corby Steel site (England and Wales High Court (Technology and Construction) Decisions, 2009). The Council spent £ 1.9 m fighting the case, whilst receiving a bill of £ 4.8 m from the claimants' lawyers for legal fees, with an undisclosed compensation amount to the families (Northamptonshire Evening Telegraph, 2009). In 2010, the Council withdrew its appeal on the decision accepting that mistakes were made in the unprofessional manner in which the clean-up was done and apologized to the affected families. An out of court settlement resulted in payments of undisclosed amounts to the families affected (The Guardian, 2010).

The Corby case led to the promulgation of laws for the regulation of remedial activity on contaminated land with the potential of atmospheric releases. It also made it a requirement that remediation activities are well planned and undertaken by professionals with the necessary skill, expertise, and knowledge about the risk involved in undertaking the cleanup or remediation (Nathanail, 2013).

Ghana: the Dimethoate spillage in Kumasi (2012) and the 3 June 2015 flood and fire disaster in Accra.

Ghana has also had environmental disasters, but detailed investigations have not been undertaken, but even when investigated, the reports are not made public, lessons are not learned, and recommendations are not implemented. Two cases are presented for comparison. On 7 December 2012, there was a report of the explosion and spillage of Dimethoate in a pesticide warehouse at Atwima Bawku, Kumasi. The spill had a pungent odor and caused breathing problems in the area (Modern Ghana, 2012; Ghana News, 2012). Dimethoate is an organophosphate that is used as a pesticide and acaricide. Dimethoate is toxic (Davies et al., 2008) and a possible mutagen and carcinogen (Hallenbeck & Cunningham-Burns, 1985; Hayes, 1982). The Ghana EPA covered the spill with polythene sheeting and spread sawdust on the spill to prevent further migration of the pesticide (Modern Ghana, 2012). To date, however, there has been no official report that has been made public on the possible causes, risk to sensitive receptors, fate and transport of the contaminant, measures to prevent a future occurrence, and a guide on the evacuation should a pesticide spillage occur. The second example is the 3 June 2015 floods and Goil fuel retail outlet explosion which resulted in the loss of 154 lives and destroyed property totaling GHC 1.6 m. The investigative report on the causes of the floods and the fire outbreak at the Goil Filling Station, near the Kwame Nkrumah Interchange suggests ineffective waste management and disposal, and poor development planning as two of the causes of the flood disaster and fire (Ministerial Investigative Committee, 2015). However, to date, the findings of the report have not been officially communicated to the public (Ghana Web, 2017), and the recommendations have not been implemented as seen in other jurisdictions previously discussed.

Brief of the UK Framework for contaminated land and risk-based land management

The largest recorded numbers of contaminated lands are found in the developed economies especially Europe and North America. These contaminated lands have resulted from the legacy of past activities like industrialization, war, spillage, and poor environmental legislation (Nathanail, 2009; Petts et al., 1997; Pollard et al., 2001). For this reason, although contaminated land is a recent subject, it has drawn the attention of the public and regulators alike. In the developing world, however, unmanaged contaminated lands are becoming prevalent because of poor planning, rapid urbanization, and mining with their attendant poor waste management and disposal practices

(Asante-Duah & Sam, 1995; Mensah et al., 2015; Petts et al., 1997). Teh et al. (2016) presents a summary of the contaminated land management framework in some jurisdictions and is referred to for further reading. Although they have slight differences due to jurisdiction modifications, they all have the aim of proactively preventing land contamination, and in case of contamination occurring, use a risk-based approach to manage the land considering its future use. In this paper, a brief of the UK's framework will be presented, with the aim that Ghana adopts a risk-based contaminated land policy that suits Ghana's development stage.

In the UK context, contaminated land is 'any land which appears to the local authority in whose jurisdictions it is located to be in such a condition, by reason of substances in, or under the land that – i. significant harm is being caused or there is a significant possibility of such harm being caused; or ii. significant pollution of controlled waters being caused or there is a significant possibility of such being caused' (Nathanail, 2009; Petts et al., 1997; Pollard et al., 2001).

Risk-based contaminated land management framework and policy centers around the prevention, identification, and removal of elevated risks to human health, the environment, and property (Figure 2). The rest of the presentation of the framework is extracted from Petts et al. (1997), Nathanail (2009), and the British Standard Institution (2001 & 2017). The methodology in Figure 2 is based on a tiered approach with the aim of collecting more data to reduce the uncertainty of the site if need be. However, the process can also stop if it is realized early on that the site does not pose a risk.

The framework and its process involve identifying a source of contamination, its potency to cause harm to a receptor via an exposure pathway, and an evaluation of the risk to receptors. This means that land can only be declared a contaminated land if there is a route for the contaminant source to reach a receptor, considering the future use of the land.

Hazard identification involves the characterization of source-pathway-receptor (SPR) from a desk study, followed by a site reconnaissance of the land, with the aim of understanding the historical use of the land and whether there are potential sensitive receptors at risk. Hazard identification results in the drawing up of an initial conceptual model statement that factors in the topography, geology, hydrogeology, and surface hydrology of the land and its surrounding areas. Figure 3 presents an example site conceptual model for a former foundry/mining site.

The site conceptual model development involves the iterative approach of continuously gathering, reviewing, and reevaluating available site information and characteristics to give a better understanding of the SPR connection and characteristics, whilst leaving behind an audit trail of evidence source(s) to ensure that the logical, justifiable, and consistent methodologies that led to the development of the site conceptual model can be reviewed and audited by other specialists and

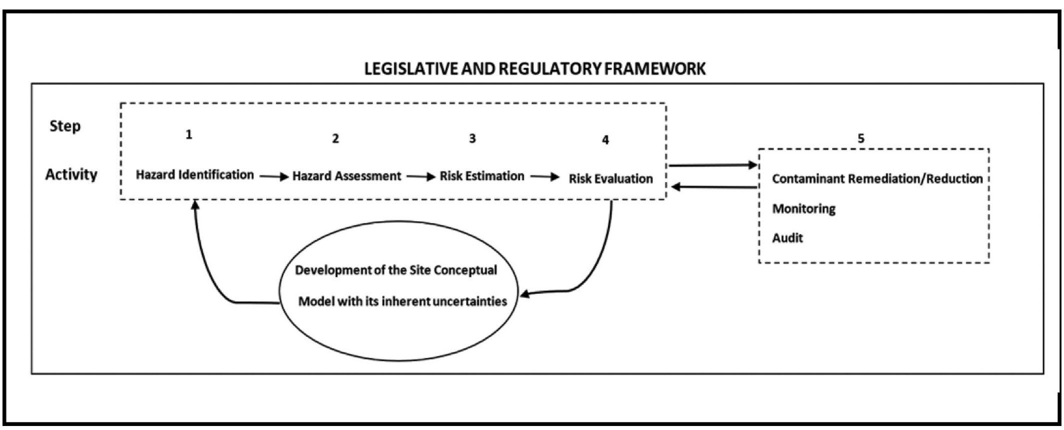

Figure 2. Summary of the UK risk-based contaminated land management framework and methodology.

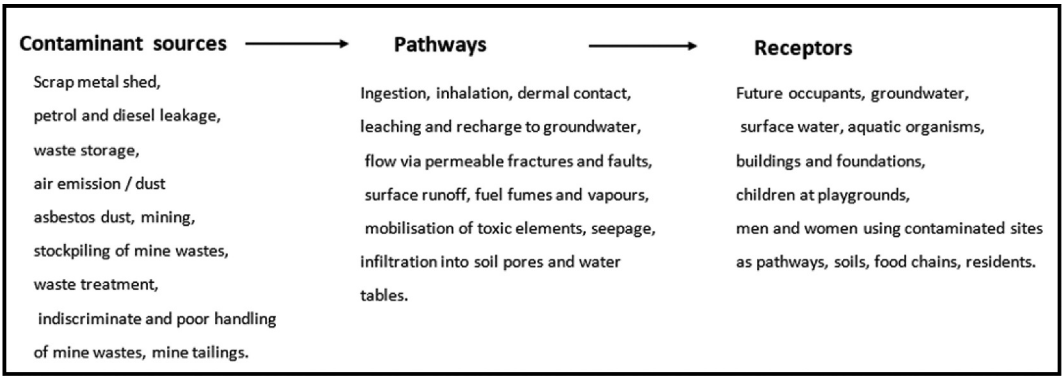

Figure 3. Example site conceptual model statement for the construction of apartments on a previous foundry/mining site.

regulators alike. The iterative nature of the conceptual model development ensures the constant questioning and querying of the current understanding of SPR processes, leading to the formulation of further data collection campaigns for the improvement of the model to reduce uncertainties for effective decision-making for the site (Brassington & Younger, 2010; Environment Agency, 2001; Nathanail, 2013).

An initial guess of the contaminant source can be deduced from the land-use history and followed later by site visits. The source could be natural (natural methane, CO_2, radon, arsenic, fluoride) or anthropogenic (metals, organics, toxic chemicals, fecal matter). The topography, geology, and hydrogeology can be obtained from reports and previous characterization of the area under which the site falls. The results from the desk study will then inform the development of the initial conceptual model, which can be later tested and validated by collecting and analyzing quantifiable information on the geology and contaminant concentration from geochemical and soil sampling and core logging via a limited or detailed site investigation.

Hazard assessment focusses on refining the initial conceptual model by understanding the pathways by which the source can reach the receptor (Figure 3). The contaminant concentrations can be compared to generic guideline values of the legal framework before considering to progress to the next stage. The pathways could be high permeability structures for gas and liquid migration, bedding planes, faults, and joints in the ground. Steep slopes can also provide runoffs to surface waterbodies. Other pathways include inhalation, ingestion, and dermal contact. Receptors include humans, buildings, surface water, aquifer, plants and animals, and game reserves, among others. Knowledge of and an understanding of contaminant transformation and attenuation processes like dilution, dispersion, and biodegradation are also important for pathway characterization.

Risk estimation involves the assessment of the exposure and effects of the contaminant on the receptor under consideration. Refer to the estimation methods used by Armah and Gyeabour (2013), Rinklebe et al. (2019), and Mensah et al. (2020) in previous works. The risk estimation stage is the most difficult stage of the risk assessment process as most of the data requirements for characterization are usually not available, and even if available are fraught with lots of uncertainty. The exposure assessment identifies the rate of contaminant movement, characteristics of contaminant medium, contaminant reduction and transformation reactions, and the characterization of the exposure route and frequency of contact between the contaminant and receptor. For humans, for example, primary routes for exposure to heavy metal on a contaminated land may include dust and vapor inhalation, indirect ingestion via contaminated food and water, direct ingestion of dust and soil, and dermal contact. For soil ingestion by a child for example, uncertainty about how much soil the child ingests per day, and the number of days of ingestion makes it difficult for exposure assessment. Contaminant effect assessment involves the description and quantification of the relationship between contaminant exposure and the adverse health or environmental effects on the receptor. The result of risk estimation is the production of a dose–response relationship between the contaminant and the receptor.

Risk evaluation considers the conceptual model, the risk estimation, and its inherent uncertainties, with a focus on sensitivity analyses of the input parameters and the decision to take action. After risk evaluation, risk reduction comes into the process, with a consideration of the legislative, political, socio-economic, ecological, community, and ethical interests at play at the time of the risk assessment. Risk reduction, therefore, takes the risk assessment beyond the technical science to the platform of public discourse for effective and integrated decision-making should risk reduction or remediation becomes options. The reduction involves either removing, destroying, or detoxifying the source, interrupting the pathway, modifying the land use, or protecting the receptor, which is covered further in texts like Wood (2001), Nathainail et al. (2007), Nathanail and Bardos (2007), and British Standard Institution (2017).

The process of risk-based contaminated land management is iterative (Nathanail, 2013; Petts et al., 1997), but enables the Council (Metropolitan, Municipal, and District Assemblies (MMDAs) in Ghana's case) to permit a potential developer to go on with a development (if there is no or low risk to receptors) or to grant the permit with the condition of undertaking remediation on the site or an outright refusal of the permit for the protection of sensitive receptors.

Professional requirements for the implementation of the risk-based contaminated land management process and challenges for framework implementation

Risk-based contaminated land management is a multidisciplinary (Nathanail, 2009, 2013; Petts et al., 1997; Syms, 1996) field requiring the expertise of the natural sciences, social sciences, and engineering with geosciences as the core of the process (Figure 4) in the development of the site conceptual model. In Ghana, the experts with the requisite knowledge and understanding in Figure 4 are available and are members of professional bodies like the Ghana Institutions of Geoscientists (GhIG), Engineering (GhIE), Surveyors (GhIS), Ghana Institute of Architects (GIA), Ghana Science Association, Ghana Bar Association (GBA), Ghana Medical Association (GMA), Ghana Journalists Association (GJA) among others who work in regulation, academia, and research as well as industry.

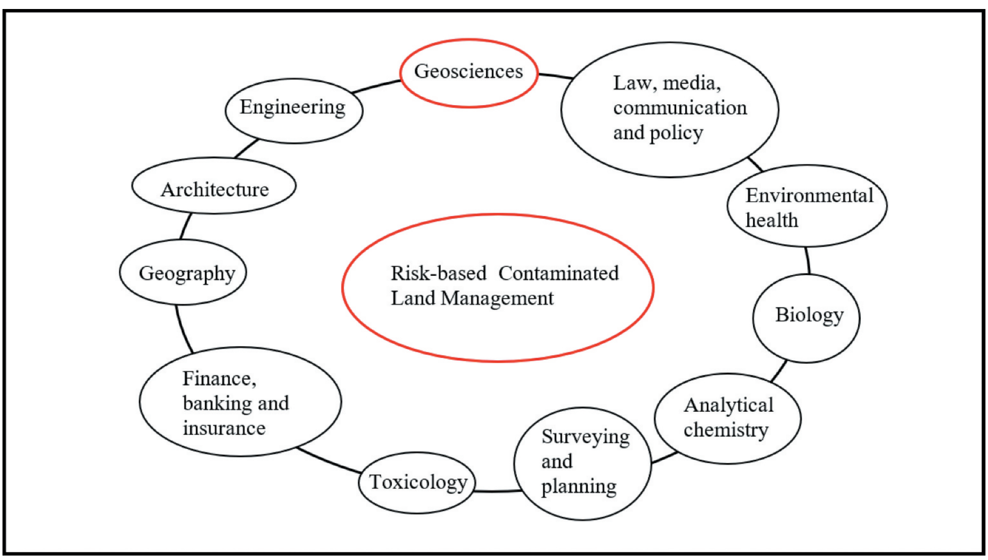

Figure 4. Skillset and expertise for undertaking risk-based contaminated land management framework, with geosciences forming the core of the framework.

Ghana will be able to implement the risk-based contaminated land should a backing regulation and legislation be passed with consideration of Ghana's socio-economic environment as demonstrated by the successful implementation of Ghana's and Africa's first environmental auditing and performance rating tool called the 'AKOBEN.' AKOBEN was a success because of the political will and involvement of high ranking government officials, as well as the strong legal backing and institutional framework and support (Darko -Mensah and Okereke, 2013).

Despite the availability of expertise for the introduction and implementation of the policy, there are potential hurdles that must be surmounted. With regard to local authorities, budget constraints for training and implementation, unavailability of current professional and qualified staff, lack of political will, fear of being sued, staff unwillingness to change, and non-clarity to technical guidance are some of the impediments to the proposed policy framework. Lack of clarity and clash and duplication of regulatory activity of government institutions will also be a major setback for implementation. For the businesses and general public, fear and suspicion of government bureaucratic processes and policies will impinge on the methodology.

To streamline the implementation of the policy, lessons learned in the UK and from other jurisdictions during the initial implementation of the framework can be used and applied in the Ghanaian context.

Conclusion and recommendations

In this paper, we presented the effects of an unavailability of a regulation and legislation of risk-based contaminated land management and its effects on sustainable development in Ghana. Example case precedents from developed jurisdictions demonstrate the economic, legal, financial, and social effects of land contamination. These precedents resulted in a change of mind-set about contamination and caused an improvement in the environmental regulation regime. For Ghana's case precedents, however, detailed investigations are not taken, and if investigated, the reports are not made public, lessons are not learned and recommendations are not implemented. One of the approaches to effectively deal with Ghana's environmental challenges is an adaption and implementation of a risk-based contaminated land policy. Ghana has the requisite human resource in the form of professionals who can implement the policy. Should a structured, consistent, and objective approach be used to educate stakeholders about contamination and its effects, there could be a progressive change of mind-sets to enable Ghana to develop sustainably.

The authors present the following recommendations that if implemented in the planning, regulatory, and governance environment will kick start the discussion on risk-based land management approach:

(i) the reintroduction, strengthening, and incentivization of environmental inspectors at the local and national level to proactively monitor and be given powers to prosecute polluters, with legal punitive measures;
(ii) MMDAs to survey and create a national land registry (via GIS and other databases) of potentially contaminated lands, for a detailed characterization of contamination;
(iii) MMDAs must regulate developments on or near former landfill sites and refuse dumps by inculcating conceptual models and risk assessments as a requirement in the building permitting process;
(iv) the EPA must undertake baseline studies of water resources and other sensitive receptors so as to finger any industry or polluting activity that contaminates receptors;
(v) the committee reports of previous environmental and pollution disasters must be re-visited and their recommendations implemented;
(vi) finally, the passing of an effective legislation by parliament to include contaminated land risk assessment and management into the building permitting process.

Disclosure statement

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