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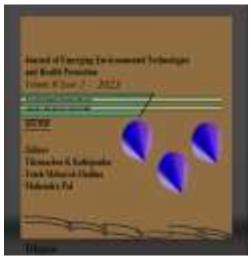

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Leachate Emissions and Digital Tools for Safe Water Resources Management and Landscape Upgrade Agritourism Facilities at Post COVID era

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Abstract

Leachate is a harmful liquid that is generated when rainwater percolates through waste materials in landfills, picking up contaminants along the way. It is essential to treat leachate to prevent contamination of soil and water sources. The working study presents a health policy framework so as to support safe sustainable ecotourism facilities within useful proposals at landscape upgrade at post COVID era. The presented working study describes a literature review of leachate treatment techniques and proposed digital tools and techniques for safe architectural landscape upgrade that could be developed for qualitative alternative types of tourism like agricultural tourism at areas next to closed landfill sites, brown fields. The working study methodology is based on sanitary digital drawings that could be utilized used properly according to geoinformation data for particular virtual learning and training policy proposals not only for tourists within alternative types of educational tourism but also for stakeholders for public health protection. Useful conclusions are made for the proper use of sanitary digital drawings and safe sustainable qualitative agricultural tourism facilities promoting sustainable green tourism and securing environmental health protection at post COVID-19 era and in climate change management. Leachate treatment schemes are presented and a relative health policy to support safe sustainable eco-tourism facilities within qualitative architectural landscape upgrade at post COVID era.

Keywords: Leachates, digital virtual learning architectural tools, architectural landscape upgrade, geoinformation utilities, sustainable agricultural tourism, sanitary digital drawings, public health.

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1. INTRODUCTION

Through this working study, it was found that the state of the art of landfill leachate treatment involves various techniques including biological treatment, physicochemical treatment, advanced oxidation processes, membrane processes, and hybrid systems. Each of these methods has its own advantages and limitations, and the choice of treatment technology depends on factors such as the characteristics of the leachate, regulatory requirements, and cost considerations [1-14, 45, 46].

Leachate is a harmful liquid that is generated when rainwater percolates through waste materials in landfills, picking up contaminants along the way. It is essential to treat leachate to prevent contamination of soil and water sources. Here are some common methods for leachate treatment as they are described below [4-13, 45,46,92].

Biological treatment methods, such as activated sludge and sequencing batch reactors, are commonly used for landfill leachate treatment due to their cost-effectiveness and ability to remove organic contaminants. However, these methods may not be effective in treating refractory compounds and inorganic pollutants present in leachate.

Physicochemical treatment methods, such as coagulation-flocculation, adsorption, and chemical precipitation, are often used as pre-treatment steps to remove heavy metals, suspended solids, and nutrients from leachate before further treatment. These methods are effective in reducing the concentration of pollutants, but may require additional treatment steps to meet discharge standards.

Advanced oxidation processes, such as ozonation, UV radiation, and Fenton's reagent, are effective in degrading refractory organic compounds present in leachate. However, these methods can be expensive and may require long treatment times to achieve complete degradation of contaminants.

Membrane processes, including ultrafiltration, nanofiltration, and reverse osmosis, are increasingly being used for leachate treatment due to their high efficiency in removing contaminants and producing high-quality effluents. Membrane technologies can be integrated with other treatment processes to achieve higher removal efficiencies and reduce operating costs.

Overall, the state of the art of landfill leachate treatment is constantly evolving as new technologies and approaches are developed to address the complex challenges associated with leachate management. Collaboration between researchers, industry professionals, and regulatory agencies is essential to advance the field and ensure sustainable solutions for leachate treatment [52-63, 64-76].

Proper leachate treatment schemes and health policy should be followed in order to support safe sustainable eco-tourism facilities, agritourism facilities within architectural landscape upgrade at post COVID era and in climate change management [15-44, 47-50].

Moreover, below are presented some common methods for leachate treatment:

Physical treatment: This involves processes such as filtration, sedimentation, and evaporation to remove solid particles and reduce the volume of leachate.

Chemical treatment: Chemicals such as lime, alum, and ferric chloride can be added to leachate to precipitate contaminants and neutralize acidity.

Biological treatment: Biological processes such as aerobic and anaerobic digestion can be used to break down organic contaminants in leachate.

Membrane filtration: This method uses membranes to separate contaminants from leachate based on size and molecular weight.

Advanced oxidation processes: Techniques such as ozonation and UV treatment can be used to destroy harmful organic compounds and pathogens in leachate.

It is important to carefully monitor and regulate leachate treatment processes to ensure that the treated wastewater meets regulatory standards before being discharged into the environment. Proper leachate treatment is crucial in protecting human health and the environment from the hazards posed by landfill leachate.

2. ENVIRONMENTAL HEALTH AND LANDSCAPE UPGRADE AT POST COVID ERA.

Nowadays, at post covid era and due to climate change more tourists, visitors would desire to travel at outdoors safe tourism places encouraging particular sustainable green tourism places supported by water resources such as agri-tourism, ecological tourism and green tourism. The main stages at landfill leachates are described below.

First phase: Aerobic phase	
Duration	some weeks
Characterisation of landfill leachate	pH ~ 8
	High levels of heavy metals
Second phase: Acidic (anaerobic) phase	
Duration	some years
Characterisation of landfill leachate	pH ~ 5
	High concentration of VFA
	High levels of BOD
	Ratio COD:BOD is low: 1.3:1 – 2.0:1
	High levels of NH_4-N, organic N and PO_4-P,
	High levels of heavy metals
Third phase: Methane phase (anaerobic)	
Duration	> 100 years
Characterisation of landfill leachate	pH ~ 7
	Low concentration of VFA
	Low levels of BOD
	Ratio COD:BOD is high 20:1 – 10:1
	High levels of NH_4-N; Moderate to low levels of organic N
	Very low levels of PO_4-P
	Low to very low levels of heavy metals, apart from Fe and Mn

Table 1. Simplified characterisation of the biological performance in a landfill related to disposal time, after Dr Sami Serti (2000)

Source: [45,46,92]

However, through the literature review, it was found that the state of the art of landfill leachate treatment involves various techniques in order to provide safe water resources, upgrading landscape, including biological treatment, physicochemical treatment, advanced oxidation processes, membrane processes, and hybrid systems [3-14]. Each of these methods has its own advantages and limitations, and the choice of treatment technology depends on factors such as the characteristics of the leachate, regulatory requirements, and cost considerations.

Biological treatment methods, such as activated sludge and sequencing batch reactors, are commonly used for landfi ll leachate treatment due to their cost-effectiveness and ability to remove organic contaminants. However, these methods may not be effective in treating refractory compounds and inorganic pollutants present in leachate. At aerobic treatment 90% removal of COD and ammoniacal nitrogen, it has high costs. At anaerobic treatment there is low cost; reduced hydraulic holding times; low sludge generation; ability to receive high concentrations of organic components. At activated sludge there is high cost while there is efficiency removal of BOD5 and COD between 90 and 99%; metal removal efficiency between 80 and 99%.

Physicochemical treatment methods, such as coagulation-flocculation, adsorption, and chemical precipitation, are often used as pre-treatment steps to remove heavy metals, suspended solids, and nutrients from leachate before further treatment. These methods are effective in reducing the concentration of pollutants, but may require additional treatment steps to meet discharge standards [8-13, 45, 46]. The coagulants concentrations are required for the system operation are very high, turning it economically unfeasible to apply this technology in a real scale due to the costs of inputs and the management of chemical sludge generated.

Advanced oxidation processes, such as ozonation, UV radiation, and Fenton's reagent, are effective in degrading refractory organic compounds present in leachate. However, these methods can be expensive and may require long treatment times to achieve complete degradation of contaminants. It presents high process costs, such as energy, the value of inputs demanded in high doses and due to the com-plexity of the operation, requires a qualified technical operator [45, 46, 92].

Membrane processes, including ultrafiltration, nanofiltration, and reverse osmosis, are increasingly being used for leachate treatment due to their high efficiency in removing contaminants and producing high-quality effluents. Membrane technologies can be integrated with other treatment processes to achieve higher removal efficiencies and reduce operating costs.

The combined treatment of leachate with sanitary effluent in Sewage Treatment Plants (STP) is widely diffused at a lot of countries worldwide for fresh leachates produced from new waste inputs at landfills. An important and current point of discussion inside the scientific community is the feasibility of co-treatment and what would be the ideal proportion of leachate / sewage in order to not harm the station and compromise the final effluent quality [8-12].

The co-treatment of leachates treatment with domestic sludge presents reduction of the COD / BOD ratio of leachate, increasing its biodegradability due to synergistic effect when it is mixed with sewage. In addition to the greater amount of organic matter available biologically, encouraging the degradation and stabilization of microorganism as well as Alkalinity, characteristic of leachates from landfills in the methanogenic phase, favors anaerobic treatments maintaining pH, eliminating the need for external means of correction.

However, for old landfills other landfill treatment designs could be used for leachate treatment like leachate recirculation at batch bioreactors and other particular schemes [3-13, 45, 46]

Overall, the state of the art of landfill leachate treatment is constantly evolving as new technologies and approaches are developed to address the complex challenges associated with leachate management. Collaboration between researchers, industry professionals, and regulatory agencies is essential to advance the field and ensure sustainable solutions for leachate treatment.

Proper monitoring schemes should exist not only for health and safety but also for sustainable outdoors tourism facilities and architectural landscape upgrade at post covid-19 era and in climate change management [1, 2, 14-16, 77-94].

3. MONITORING SCHEMES AND DIGITAL TOOLS FOR SAFE OUTDOOR TOURISM FACILITIES

Nowadays, in post pandemic era ecological outdoors travel destinations should be monitored in terms that satisfy proper standards in terms of health and safety. This includes ensuring that all facilities and accommodations are regularly cleaned and sanitized, providing easy access to handwashing stations and hand sanitizer, and promoting social distancing measures throughout the destination [1, 2, 14-16, 17-76]. Additionally, monitoring the health of staff members and visitors, offering health screenings if necessary, and implementing protocols for handling any potential health risks are crucial in maintaining a safe and enjoyable outdoor travel experience.

It is also important to educate visitors on best practices for responsible outdoor travel, such as respecting wildlife and natural habitats, practicing Leave No Trace principles, and being mindful of their environmental impact. By implementing these measures, ecological outdoors travel destinations can continue to thrive while prioritizing the health and safety of both visitors and the environment.

In next table 1 are presented some indicative magnitudes based on the literature for particular chemical indexes within landfill leachate emissions.

	Large landfill (old)	New landfill	Old landfill
Number of observations			
p	7.2	5 - 6	8 - 9
Conductivity, mS/m	543	50 – 1,400	50 – 1,400
Alkalinity, mekv/l	543		
Cl^-, mg/l	920	(5) – 1,300	1,000 – 6,000
BOD_7, mg/l	27	1,000 -2,000	10 - 800
COD, mg/l	480	1,000 -30,000	500 – 4,000
Total P, mg/l	1.1	< 24	0.1 – 4.0
NH_4-N, mg/l	240	150 - 560	80 -370
Total N, mg/l	330	800	100 - 400
Suspended Solids, mg/l	5	n.a.	n.a.

Table 1. Landfill stages and leachate emissions's indexes

Source: [45,46,92]

Moreover, treated leachates could be used for irrigations or to fill empty natural reservoirs. This can help reduce the amount of untreated leachate that is released into the environment, thus reducing the potential for contamination of soil and water sources. Additionally, using treated leachates for irrigation can help conserve water resources and provide a sustainable way to manage waste products. Overall, using treated leachates in this way can have positive environmental and economic benefits for safe travel destinations. Landscape upgrade with waterways, trees should exist applying proper monitoring schemes, gis applications , digital sanitary maps for safe ecological outdoors travel destinations [47-51, 80, 81-88].

A relative health and safety framework is presented below applying proper digital tools, techniques that can be combined with sanitary digital drawings, for soil health and safe sustainable green tourism facilities [1,2,15, 95-101]. Proper e-leanring tools with avatars could be used for relative training and marketing options between tourists and stakeholders [14,15, 47-52].

3. POLICY FRAMEWORK FOR DIGITAL TOOLS WITHIN QUALITATIVE SUSTAINABLE AGRITOURISM AND LANDSCAPE UPGRADE

This framework for soil health and safety in green tourism facilities includes the following key components:

Digital tools for soil health assessment: Use of digital soil testing kits and sensors to monitor soil quality and identify any potential contaminants or pollutants. This can help ensure that the soil is healthy and safe for visitors and wildlife.

Sanitary digital drawings: Use of digital mapping tools to create sanitary digital drawings of the green tourism facilities, including information on waste management systems, water sources, and other sanitary facilities. This can help ensure that visitors are aware of and can access necessary facilities in a safe and hygienic manner.

E-learning tools with avatars: Implementation of e-learning platforms with interactive avatars for training staff and educating visitors on soil health and safety practices. Avatars can provide a personalized and engaging learning experience, enhancing knowledge retention and promoting sustainable practices [14, 15].

Marketing options for stakeholders: Utilization of digital marketing strategies to communicate the commitment to soil health and safety to stakeholders, such as local communities, government agencies, and tourism organizations. This can help build trust and support for sustainable green tourism practices.

Overall, the integration of proper digital tools, sanitary digital drawings, e-learning platforms with avatars, and strategic marketing options can enhance soil health and safety in green tourism facilities, promoting a sustainable and enjoyable experience for visitors while protecting the environment.

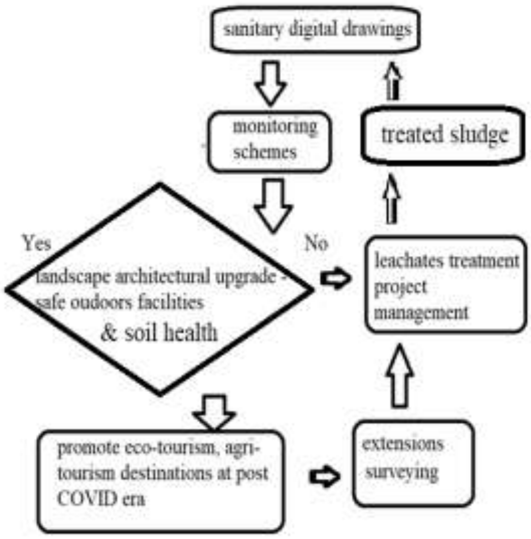

Figure 1. A health and safety framework for the promotion of safe outdoors tourism facilities

Based on the above useful projects within leachates treatment schemes could be realized for safe outdoors tourism facilities. Proper digital sanitary drawings, geoinformation digital techniques, surveying applications could be used for the maintenance, monitoring schemes, hazardous control check points (HACCP) and associative digital techniques for relative sanitary units; architectural landscape upgrade and support at ecological outdoors tourism places. In this way is protected environmental health and public health.

Some potential projects within leachates treatment schemes for outdoor tourism facilities could include:

- Implementing a leachate collection and treatment system to prevent contamination of ground and surface water sources in the surrounding area.

- Installing constructed wetlands or biofiltration systems to naturally treat leachate before it is discharged into the environment.

- Utilizing advanced technologies such as reverse osmosis or activated carbon filters to remove contaminants from leachate before disposal.

- Developing a comprehensive monitoring and maintenance plan to ensure the effectiveness of leachate treatment systems and compliance with environmental regulations.

- Educating staff and visitors about the importance of proper waste management practices and the potential impacts of leachate pollution on the local ecosystem.

By implementing the above, safe outdoor tourism facilities could exist and their landscapes can minimize their environmental footprint and provide a safe and enjoyable experience for visitors.

4. CONCLUSIONS

All the above presented are of great importance for leachates treatment and exploitation the treated discharges at water resources, waterways, particular safe bioremediation projects, and promotion through marketing advertising safe outdoors sustainable green tourism infrastructures.

These measures not only help in effectively treating leachates and minimizing environmental pollution, but also improve the overall ecosystem health and promote sustainable tourism practices. By implementing these strategies, we can ensure the protection of our water resources and create a healthier environment for future generations to enjoy protecting environmental health and public health.

Further research is needed to explore the various aspects of the investigated working study and to increase our understanding of its intricacies. However, by conducting more studies, we can enhance our knowledge and potentially find new solutions or applications for this fascinating subject. It is crucial to continue to push the boundaries of research in order to expand our understanding and make new discoveries in the field of leachate treatment and associative digital applications for sustainable safe green tourism facilities and public health protection.

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