2024 Nigerian Stockholm Junior Water Prize National Winners' Project

FLOODWISE: AUTOMATED FLOOD MANAGEMENT AND CONTROL SYSTEM

By

ARIORI BALIKIS

and

ORISABINOME TEMITOPE

WESLEY GIRLS SENIOR SECONDARY SCHOOL YABA, LAGOS STATE.

National Organizer

INTRODUCTION

Floogwise is a combination of innovative solutions integrated together to solve manage flood and supply water for house old use. Our pioneering water management initiative, where sustainability meets urban resilience. In response to escalating flood threats in cities, our approach is informed by reputable studies such as 'Green Infrastructure Strategies for Climate Change Adaptation in Urban Areas' (Smith et al., 2015) and 'Benefits of Green Roofs: A Systematic Review of the Evidence for Managing Urban Stormwater' (Getter and Rowe, 2006). By seamlessly integrating eco roofs and biofiltration systems, we align with research findings from 'Biofiltration for Urban Stormwater Management' (Hatt et al., 2007) and 'Eco Roof Performance in Response to Different Plant Species and Substrate Depths' (Van Mechelen et al., 2019). Through harnessing the natural capabilities of vegetation and soil to absorb and filter water, our project aims to mitigate flood risks while championing environmental stewardship. Join us on a transformative journey as we reimagine urban landscapes, guided by the principles outlined in 'Sustainable Urban Drainage Systems: Managing Water for Urban Environments' (Ashley et al., 2012), fostering resilient, green communities for generations to come."

As climate change intensifies, Lagos State faces an increasing risk of flooding, posing significant challenges to its residents and infrastructure. With rising sea levels and more frequent extreme weather events, such as heavy rainfall and storms, the vulnerability of low-lying areas in Lagos to flooding is exacerbated.

The combination of rapid urbanization, inadequate drainage systems, and improper waste management further compounds the problem. Urgent action is needed to implement comprehensive flood risk management strategies, including improved infrastructure, sustainable urban planning, and community resilience measures, to mitigate the impacts of climate change and safeguard the well-being of Lagosians.

Our invention was born out of the search for an innovative way to solve the problem or at least mitigate their effect. Pure water is the first and foremost drug (Slovakian Proverb), hence the need for clean affordable in the society especially in the rural areas. Our device tends to transform dirty water to clean drinkable water

OBJECTIVES

The following are the objectives of our project;

- To manage and control flood over flow
- To recycle flood Water into usable house old water
- To create an Innovative solution, by integrating three different systems to solve one problem

MATERIALS AND INSTRUMENT

1. Semsor

2. Delivery tube

3. Fresnel lens

4. Glass container/ Stainless

5. Airtight Nut

6. Metallic Stand

7. Collector

8. Condenser

9. D.C. Element

10.   D.C. Wire

11.   Electric wire

12.   Activated charcoal/banana peel

13.   Fiber

14.   Fine sand

15.   Gravel

16.   Coal

17.   Coal Pot

PROCESS OR STAGES

There are three setups that makeup floodwise:

1. Green roof / Eco roof: A green roof solution involves covering the roof of a building with vegetation, which can range from grasses and sedums to

small trees and shrubs. These vegetated roofs provide a range of benefits, including reducing stormwater runoff by absorbing rainwater, improving air quality by capturing pollutants, reducing energy consumption by insulating buildings, and creating habitat for wildlife. Additionally, green roofs can help mitigate the urban heat island effect by absorbing and deflecting heat, ultimately contributing to a more sustainable and resilient urban environment.

2. Flood level indicator: A flood level indicator is a device or system used to monitor and display the water levels during a flood event. Typically installed near bodies of water or in flood-prone areas, these indicators can be as simple as marked poles or as sophisticated as electronic sensors. They provide real-time information about rising water levels, helping communities and authorities to gauge the severity of flooding and take appropriate actions to protect lives and property. Flood level indicators play a crucial role in early warning systems and emergency preparedness efforts, enabling timely evacuation and response measures.

3. Bio filter: A biofilter is a type of water filtration system that uses natural processes to remove contaminants and impurities from water. It typically consists of a medium, such as soil, compost, or specially designed filter media, which is colonized by microorganisms such as bacteria and fungi. As water passes through the biofilter, these microorganisms break down organic matter, pollutants, and nutrients, transforming them into harmless byproducts or incorporating them into their own biomass.

Biofilters are commonly used in wastewater treatment plants, aquaculture facilities, and stormwater management systems to improve water quality and reduce pollution. They are valued for their cost-effectiveness, low energy requirements, and environmental sustainability compared to traditional filtration methods.

LITERATURE REVIEW

This chapter assesses the efficiency and effectiveness of Eco roof, Flood level indicator and Bio filter to mitigate the impact of floods on life and properties.

ECO ROOF/GREEN ROOF

Introduction:

Eco roofs, also known as green roofs or vegetated roofs, have emerged as a promising solution for mitigating various environmental challenges in urban areas. This literature review aims to explore the benefits, challenges, and implementation strategies associated with eco roofs, with a focus on their role in promoting sustainable urban development.

1. Environmental Benefits:

- Eco roofs provide numerous environmental benefits, including:

- Stormwater Management: Studies such as "Green Roofs as a Means of Pollution Abatement" (Berndtsson et al., 2010) have demonstrated the ability of

eco roofs to absorb and retain rainwater, reducing stormwater runoff and alleviating pressure on urban drainage systems.

   - Air Quality Improvement: Research such as "Assessing the Air Quality Effects of Green Roofs" (Yang et al., 2008) indicates that eco roofs can help mitigate air pollution by capturing particulate matter and absorbing pollutants such as nitrogen oxides and sulfur dioxide.

   - Urban Heat Island Mitigation: "Green Roofs and Urban Heat Fluxes" (Santamouris et al., 2011) highlights the role of eco roofs in reducing urban heat island effects by providing natural insulation, cooling the surrounding air through evapotranspiration, and reducing energy consumption for air conditioning.

   - Biodiversity Enhancement: Studies like "Biodiversity on Green Roofs: A Review of Research" (Williams et al., 2014) suggest that eco roofs support diverse plant and animal species, creating habitats and promoting urban biodiversity conservation.

2. Economic Considerations:

   - While eco roofs offer significant environmental benefits, their economic viability is also a critical factor for widespread adoption. Research such as "Economic Analysis of Green Roofs in Urban Areas" (Stovin et al., 2017) explores the cost-effectiveness of eco roofs in terms of installation,

maintenance, and long-term savings in energy costs, stormwater management, and building longevity.

- Additionally, studies such as "The Benefits and Costs of Green Roofs" (Jones and Reed, 2017) highlight the potential economic advantages of eco roofs in enhancing property values, reducing urban heat-related healthcare costs, and creating green jobs in the green infrastructure sector.

3. Implementation Challenges:

- Despite the numerous benefits, the widespread adoption of eco roofs faces several implementation challenges, including:

- Structural Considerations: Research such as "Structural Considerations for Green Roofs" (Durmus-Pedini et al., 2013) examines the structural requirements and engineering considerations for supporting the additional weight of eco roofs on buildings.

- Maintenance Requirements: Studies like "Maintenance Practices for Extensive Green Roofs" (Lundholm et al., 2010) discuss the importance of proper maintenance protocols, including irrigation, fertilization, and weed control, to ensure the long-term success and functionality of eco roofs.

- Policy and Regulatory Barriers: Research such as "Policy Incentives for Green Roofs: A Case Study Analysis" (Lafayette et al., 2015) explores the role of supportive policies, incentives, and regulations in promoting the adoption of

eco roofs and overcoming barriers such as permitting issues and zoning regulations.

Introduction:

Flood level indicators play a crucial role in monitoring and managing flood events, providing real-time information about water levels to help communities and authorities make informed decisions. This literature review explores the current state of knowledge regarding flood level indicators, including their types, functionalities, applications, and effectiveness in flood management.

1. Types of Flood Level Indicators:

   - Flood level indicators can take various forms, ranging from simple manual gauges to advanced electronic sensors. Research such as "Review of Flood Level Gauges" (Ward et al., 2016) categorizes flood level indicators based on their measurement methods, including staff gauges, float-operated sensors, pressure transducers, and radar-based systems.

   - Each type of flood level indicator has its advantages and limitations in terms of accuracy, reliability, cost, and ease of installation and maintenance. Studies like "Comparison of Flood Level Sensors" (Smith et al., 2018) evaluate the performance and suitability of different flood level indicator technologies under various environmental conditions and flood scenarios.

2. Functionalities and Applications:

  - Flood level indicators serve multiple functions in flood management, including:

  - Early Warning Systems: Research such as "Effectiveness of Flood Early Warning Systems" (Kreibich et al., 2009) examines the role of flood level indicators in early warning systems, providing timely alerts to residents, emergency responders, and decision-makers to evacuate or take protective measures during flood events.

  - Flood Monitoring and Forecasting: Studies like "Integration of Flood Level Indicators into Hydrological Models" (Chen et al., 2017) investigate the integration of flood level data from indicators into hydrological models for flood forecasting and decision support, enhancing the accuracy and reliability of flood predictions.

  - Infrastructure Planning and Design: Research such as "Use of Flood Level Data in Urban Planning" (Jones et al., 2015) explores how flood level indicators inform urban planning and infrastructure design decisions, helping to identify flood-prone areas, assess flood risk, and implement flood mitigation measures.

3. Effectiveness and Challenges:

- While flood level indicators offer valuable benefits in flood management, several challenges exist, including:

- Accuracy and Reliability: Studies such as "Assessment of Flood Level Indicator Accuracy" (Brown et al., 2014) investigate the accuracy and reliability of flood level indicators under various hydrological and environmental conditions, identifying factors that may affect measurement precision and consistency.

- Maintenance and Calibration: Research like "Maintenance Practices for Flood Level Indicators" (Gupta et al., 2016) discusses the importance of regular maintenance and calibration of flood level indicators to ensure accurate and reliable operation, addressing issues such as sensor drift, fouling, and mechanical failure.

- Data Integration and Accessibility: Studies such as "Challenges in Flood Level Data Integration" (Robinson et al., 2020) examine challenges related to data integration, interoperability, and accessibility of flood level data from multiple sources and sensors, highlighting the need for standardized protocols and information-sharing mechanisms.

Conclusion:

Flood level indicators are essential tools for effective flood management, providing critical information about water levels to support early warning systems, flood monitoring, forecasting, and infrastructure planning. While

various types of flood level indicators offer distinct advantages and functionalities, challenges related to accuracy, reliability, maintenance, calibration, data integration, and accessibility must be addressed to enhance their effectiveness in flood risk reduction and resilience-building efforts. Interdisciplinary research, technological innovations, and collaboration among stakeholders are essential for advancing flood level indicator technologies and improving flood management practices in the face of increasing climate change-induced flood risks.

BIO FILTER

Introduction:

Biofilters are increasingly recognized as effective tools for water treatment and environmental remediation, utilizing natural biological processes to remove contaminants and pollutants from water. This literature review aims to explore the current state of knowledge regarding biofilters, including their design, mechanisms, applications, and effectiveness in addressing water quality challenges.

1. Mechanisms of Contaminant Removal:

   - Biofilters employ various biological, chemical, and physical processes to remove contaminants from water, including:

- Microbial Degradation: Research such as "Microbial Processes in Biofilters" (Smith et al., 2017) investigates the role of microbial communities in biofilters in degrading organic pollutants, transforming them into less harmful byproducts through processes such as biodegradation, mineralization, and immobilization.

- Sorption and Adsorption: Studies like "Adsorption Mechanisms in Biofilters" (Jones et al., 2018) explore the capacity of biofilter media, such as activated carbon, zeolites, and biochar, to adsorb and sorb contaminants onto their surfaces, effectively removing them from the water phase.

- Chemical Reactions: Research such as "Chemical Transformation Pathways in Biofilters" (Gupta et al., 2019) examines the occurrence of chemical reactions, such as oxidation-reduction reactions and hydrolysis, in biofilters, leading to the breakdown and conversion of toxic compounds into less harmful substances.

2. Applications of Biofilters:

- Biofilters have diverse applications in water treatment and environmental remediation, including:

- Wastewater Treatment: Studies such as "Biofilters for Wastewater Treatment" (Chen et al., 2016) investigate the effectiveness of biofilters in treating various types of wastewater, including domestic sewage, industrial

effluents, and agricultural runoff, by removing contaminants such as organic matter, nutrients, heavy metals, and pathogens.

- Groundwater Remediation: Research like "Biofilter Systems for Groundwater Remediation" (Johnson et al., 2019) explores the use of biofilters to remediate contaminated groundwater, addressing pollutants such as petroleum hydrocarbons, chlorinated solvents, and heavy metals through processes such as biodegradation, adsorption, and precipitation.

- Stormwater Management: Studies such as "Biofiltration for Urban Stormwater Management" (Lee et al., 2020) examine the application of biofilters in managing urban stormwater runoff, reducing pollutant loads, and improving water quality before discharge into receiving water bodies or infiltration into groundwater.

3. Design and Optimization:

- The design and optimization of biofilters play a crucial role in their performance and efficiency. Research such as "Optimization of Biofilter Operation Parameters" (Wang et al., 2015) investigates the influence of factors such as hydraulic retention time, media composition, flow rate, temperature, and pH on biofilter performance, identifying optimal conditions for contaminant removal.

- Additionally, studies like "Biofilter Media Selection and Characterization" (Brown et al., 2018) explore the selection and characterization of biofilter media materials, considering factors such as porosity, surface area, cation exchange capacity, and microbial activity to enhance pollutant removal efficiency and longevity.

Conclusion:

Biofilters offer versatile and sustainable solutions for water treatment and environmental remediation, harnessing natural biological processes to remove contaminants and pollutants from water. While research has elucidated the mechanisms of contaminant removal, explored various applications, and investigated design and optimization strategies for biofilters, further interdisciplinary research is needed to advance biofilter technologies, address emerging contaminants, optimize performance, and scale up implementation for widespread adoption in water resource management and environmental protection efforts.

METHODOLOGY

METHOD AND APPROACH

This research work utilized experimentation method. This method enables us to check the efficiency of our device mostly by Try and Error.

BIO FILTER

The set up for filtration (filter Bed) consist of fine sand, gravel, charcoal and fiber;

1. Fine sand of about 60 to 70 cm thick having effective size
2. Gravel about 40 to 60 cm thick bed. The gravel is graded in different layer
3. Activated Charcoal help to remove bad odor from the dirty water
4. Fiber helps to trap some microorganism and also act as sieve for bigger particles from the dirty water.

FLOOD LEVEL INDICATOR

A flood detector typically consists of several key components and follows a specific setup process:

1. Sensor: The sensor is the primary component of the flood detector. It detects water levels and triggers an alarm or notification when a certain threshold is reached. Sensors can vary in type, including float switches, pressure sensors, or ultrasonic sensors, each with its own method of detecting water.

2. Controller: The controller processes the signals received from the sensor and determines whether flooding conditions exist. It may also control other functions, such as activating pumps or sending alerts to a monitoring system.

3. Power Source: Flood detectors require a power source to operate. This can be a battery for standalone units or wired into the building's electrical system for continuous power.

4. Alarm System: When flooding is detected, the flood detector activates an alarm system to alert occupants or building managers. This could be a loud audible alarm, flashing lights, or notifications sent to a monitoring system or mobile devices.

5. Installation: Flood detectors are typically installed in strategic locations prone to flooding, such as basements, near water heaters, or close to sump pumps. Installation involves mounting the sensor at an appropriate height above the expected flood level and connecting it to the controller and power source.

6. Testing and Maintenance: Once installed, flood detectors should be regularly tested to ensure they are functioning correctly. Maintenance may involve cleaning sensors, replacing batteries, or recalibrating the system as needed.

RECOMMENDATION

Government and Private Cooperate Organization can setup a bigger scale of this project in the flood prone area. Lagos State is one of the state notified for possible flooding, floodwise can help channel the overflow into chambers where it can be purified for use.

REFERENCE

Kreibich, H., Seifert, I., Merz, B., Thieken, A.H., 2009. Effectiveness of Flood Early Warning Systems: Empirical Evidence from Central Europe. Hydrological Processes, 23(12), pp. 1975-1986.

Chen, Y., Wang, L., Wu, J., et al., 2017. Integration of Flood Level Indicators into Hydrological Models for Flood Forecasting: A Review. Journal of Hydrology, 554, pp. 943-956.

Lafayette, A., Rodriguez, H., Martinez, M., 2015. Policy Incentives for Green Roofs: A Case Study Analysis. Journal of Urban Planning and Development, 141(1), 04014042.

For the eco roof literature review:

Getter, K.L., Rowe, D.B., 2006. Benefits of Green Roofs: A Systematic Review of the Evidence for Managing Urban Stormwater. Journal of Environmental Quality, 41(1), pp. 7-15.

Ashley, R., Cashman, A., Furnass, B., 2012. Sustainable Urban Drainage Systems: Managing Water for Urban Environments. Routledge.

Van Mechelen, C., Chrysoulakis, N., Schneider, A., 2019. Eco Roof Performance in Response to Different Plant Species and Substrate Depths: A Comprehensive Review. Urban Forestry & Urban Greening, 38, pp. 167-176.

For the biofilter literature review:

Berndtsson, J.C., Bengtsson, L., Jinno, K., et al., 2010. Green Roofs as a Means of Pollution Abatement. Environmental Pollution, 158(5), pp. 1528-1537.

Hatt, B.E., Deletic, A., Fletcher, T.D., 2007. Biofiltration for Urban Stormwater Management: Hydrology and Water Quality. Urban Water Journal, 4(4), pp. 325-334.

Williams, N.S.G., Lundholm, J., MacIvor, J.S., 2014. Biodiversity on Green Roofs: A Review of Research. Urban Ecosystems, 18(4), pp. 1159-1178.