
THE IMPACT OF DEVELOPMENT ON URBAN WATERSHEDS IN NIGERIA

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Abstract

This paper examines the effects of urban development on urban watersheds, highlighting the interactions between land use changes and watershed health. Urban watersheds play a crucial role in maintaining the environmental health and infrastructure of metropolitan areas. However, urbanization significantly impacts these watersheds, leading to water quality degradation, increased flooding, habitat destruction, and socio-economic challenges. The study discusses the consequences of increased impervious surfaces, pollutant loads, and habitat loss on watershed functions. Strategies to mitigate these impacts, including green infrastructure, riparian buffer zones, sustainable urban planning, and community involvement, are also explored. The study underscores the need for integrated watershed management to preserve the vital ecological functions of urban watersheds and enhance the overall well-being and resilience of cities. It was concluded that urban watersheds are critical for sustaining the environmental health and infrastructure of metropolitan areas. These watersheds perform vital functions, including water purification, flood control, and providing habitats for diverse species, which are essential for maintaining ecological balance and supporting urban biodiversity. It was recommended among other that there should be the adoption of green roofs and permeable pavements to reduce surface runoff and promote groundwater recharge and there should be the development and implementation of integrated watershed management plans that consider ecological, social, and economic factors to ensure the sustainable management and rehabilitation of urban watersheds.

Keywords: Urban watersheds, Development impact, Nigeria

Introduction

Urban development exerts profound influence on watersheds, significantly altering hydrological processes, water quality, and ecosystem health. As cities expand, natural landscapes such as forests, wetlands and open spaces are replaced with impervious surfaces like roads, building and parking lots. These changes disrupt the natural water cycle, leading to numerous environmental, social and economic consequences. An urban watershed refers to a specific land area in a metropolitan region that serves as a drainage point for all water flowing into a shared body of water, such as a river, lake, or estuary. Urban watersheds are essential for maintaining the environmental well-being and infrastructure of cities. They have the responsibility of capturing, storing, and overview. An urban watershed refers to a specific land area inside a metropolitan region that serves as the source for all water that flows into a shared body of water, such as a river, lake, or estuary. Urban watersheds are essential for maintaining the environmental well-being and infrastructure of cities. They have the responsibility of catching, storing, and releasing water, which is crucial for regulating the hydrologic cycle and providing vital ecosystem services (Carter et al., 2018).

Urban watersheds have essential roles in activities such as purifying water, controlling floods, and providing habitats for diverse forms of life (Booth & Jackson, 1997). They collect water from the atmosphere, enabling it to seep into the soil and replenish underground water reservoirs (Arnold & Gibbons, 1996). The presence of plant and soil in urban watersheds facilitates the removal of pollutants and sediment, hence enhancing the quality of water. In addition, the presence of natural areas in urban watersheds might contribute to the reduction of floods by decelerating the movement of storm water runoff (Paul & Meyer, 2001). These green spaces also serve as crucial habitats for a diverse range of plant and animal species, hence promoting urban biodiversity (McKinney, 2002).

Urbanization can have a substantial impact on the composition and operation of urban watersheds, frequently resulting in diminished water quality, heightened flooding, and habitat loss (Walsh et al., 2005). Impervious surfaces such as roads and buildings hinder the land's capacity to absorb water, resulting in accelerated runoff and increased peak flows (Brabec et al., 2002). Urban activities can release pollutants that can taint water, leading to harm to aquatic ecosystems. Consequently, there is an increasing acknowledgement of the necessity to oversee and rehabilitate urban watersheds in order to preserve their crucial ecological functions and bolster the overall well-being and adaptability of cities (Roy et al., 2008). The primary goal of this position paper is to examine the effects of urban development on urban watersheds. This entails a thorough examination of how development activities impact the inherent functioning of watersheds, resulting in diverse environmental, social, and economic outcomes.

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Overview of urban development

Urban development refers to the systematic expansion and improvement of physical infrastructure, including buildings and facilities, inside urban areas. Its purpose is to facilitate modernization, accommodate population growth, and stimulate economic progress. Typically, this involves tasks such as constructing residential, commercial, and industrial structures, expanding transportation systems (e.g., roads, highways, and railroads), installing utilities (e.g., water, sewage, and electricity), and creating public areas (e.g., parks and recreational spaces) (Batty, 2008).

Urban development is primarily propelled by three factors: population growth, economic expansion, and the aspiration for modernization. Population growth leads to increased demand for housing, services, and employment opportunities. Economic expansion drives the need for commercial and industrial development. Modernization often involves replacing older buildings with newer, more efficient ones (Fang & Yu, 2017). The need for improved living conditions, increased accessibility and connection, and the pursuit of sustainable practices can also drive urban growth (UN-Habitat, 2020).

Urban expansion can, however, also lead to challenges such as increased traffic congestion, air and water pollution, loss of green spaces, and socioeconomic disparity (Newman & Kenworthy, 1999). Urban designers and lawmakers often prioritize the promotion of sustainable development methods, such as transit-oriented development, mixed-use zoning, and green infrastructure, as a means to address these issues (Cervero & Kockelman, 1997). Mixed-use zoning encourages the incorporation of residential, commercial, and recreational areas to foster vibrant and pedestrian-friendly neighborhoods. On the other hand, transit-oriented development aims to reduce reliance on cars by promoting higher-density construction near public transportation hubs. Green infrastructure refers to the incorporation of green spaces and natural systems into urban development with the goal of enhancing environmental resilience and sustainability (Benedict & McMahon, 2006).

Concept of watersheds

Watersheds, often referred to as drainage basins or catchment areas, are geographical areas where water from rainfall or other forms of precipitation collects and converges at a certain point, such as a stream, river, lake, or ocean. The limits of a watershed are delineated by the existence of topographical features such as hills and ridges, which direct the flow of water. Watersheds play a crucial role in preserving ecological balance and ensuring the proper functioning of the hydrological cycle. Watersheds perform various crucial functions that are

essential for the well-being of humans and the health of the environment. They are initially crucial for recharging groundwater. Water that infiltrates the soil replenishes aquifers, ensuring a consistent source of groundwater for domestic, industrial, and agricultural purposes (Winter et al., 1998). Furthermore, watersheds serve as inherent purifiers. Vegetation and soil in the watershed act as a means to capture pollutants and sediments, so enhancing the overall quality of water that ultimately flows into rivers, lakes, and other bodies of water (Meyer et al., 2003). Furthermore, watersheds provide habitats for a diverse array of flora and fauna. The maintenance of biodiversity by healthy watersheds contributes to the development of ecological resilience and stability (Naiman et al., 1992). Watersheds are also crucial for flood control. Ecological features within watersheds, such as wetlands and forests, have the ability to collect and decelerate runoff, therefore reducing the risk of flooding (Poff et al., 1997).

Interaction between Development and Watersheds

The interaction between development and watersheds is a complex and dynamic process that fundamentally alters hydrological cycles, water quality and ecosystem health. Urbanization and land development disrupt the natural balance of watersheds leading to significant environmental consequences. The development of urban areas involves significant land transformation that are once capable of absorbing and regulating water flow into impervious surfaces, fundamentally changing how water interacts with the environment. Watersheds refer to areas of land where all the water that is either beneath them or flows off them ultimately converges into a common location, typically streams, rivers, or lakes. These watersheds are crucial for recharging groundwater, filtering pollution, and providing habitats for several species. The well-being of metropolitan areas is significantly influenced by the condition of their watersheds, which in turn has a direct impact on several aspects such as recreational opportunities and the availability of clean drinking water (Booth & Jackson, 1997).

Urban growth has a significant impact on the conditions and functioning of watersheds. The characteristics of the land, plants, and soil undergo substantial transformations as it is converted from its natural state to being used for residential, commercial, and industrial purposes. This leads to a rise in impermeable surfaces such as roads, buildings, and parking lots, which in turn reduces the land's ability to absorb and retain water (Arnold & Gibbons, 1996). Urbanization primarily impacts hydrology by increasing the frequency and intensity of flooding, reducing the amount of natural water flow, and increasing the amount of sediment and pollution entering water bodies (Paul & Meyer, 2001).

Research has shown that even small quantities of 10-20% impermeable terrain in a watershed can lead to significant degradation of streams (Schueler, 1994). Urbanization modifies the water balance by increasing surface runoff and reducing evapotranspiration rates, resulting in significant changes. Excessive water usage can strain water resources and lead to issues of water quality in neighboring communities (Roy et al., 2008). In addition to its impact on the environment, urbanization can also have social and economic consequences. The increasing occurrence of floods necessitates costly measures to mitigate its effects, causes disruption to individuals, and results in damage to infrastructure and property. Water quality degradation has negative impacts on water supply, recreational activities, and aquatic habitats (Walsh et al., 2005). The interaction between urban growth and watersheds is often complex and has significant repercussions that require careful consideration and control (Bernhardt & Palmer, 2007).

Effect of Development on Urban Watershed

Urban development can significantly impact watersheds, the areas of land that drain into a particular body of water. These impacts can be broadly categorized into four main areas: water quality degradation, increased flooding, habitat destruction and biodiversity loss, and socio-economic implications.

1. Water Quality Degradation: An alarming outcome of development is the deterioration of water quality in watersheds (Kuo et al., 2000). As urbanization occurs, the conversion of natural landscapes into infrastructure such as highways, parking lots, and buildings reduces the permeability of the earth. This diminishes the soil's capacity to absorb and purify rainwater, resulting in heightened runoff. The runoff frequently transports contaminants such as oil, heavy metals, pesticides, and surplus nutrients from fertilizers. The heightened accumulation of pollutants can result in significant repercussions. Nutrient contamination can result in eutrophication, a phenomenon characterized by the overstimulation of plant growth in lakes and rivers due to an overabundance of nutrients. The proliferation of this organism leads to a reduction in the concentration of oxygen in the water, resulting in detrimental effects on aquatic organisms and rendering the water unfit for human use (Smith et al., 1999).

2. Increased Flooding: Urban growth has a profound impact on the natural water cycle of a watershed. Impervious surfaces hinder the infiltration of rainwater into the earth, resulting in increased runoff volumes during rainfall. This can lead to an increased occurrence and intensity of flooding. In addition, heightened runoff has the potential to rapidly infiltrate streams and rivers, resulting in the erosion of stream banks and the deposition of material downstream (Schueler, 1995). Although storm drains can assist in controlling a portion of this surplus water, they frequently become inundated during periods of intense precipitation. Urban floods can result in property damage, infrastructural disruption, and community disruption (Fletcher et al., 2014).

3. Habitat Destruction and Biodiversity Loss: Development frequently entails the removal of vegetation and the modification of natural environments. The destruction of key habitats for wildlife and the subsequent reduction in total biodiversity within the watershed might occur (Arnold & Gibbons, 1996). Wetlands, riparian zones, and forested areas are highly susceptible to development and have a crucial function in preserving the health of watersheds. These natural regions offer crucial habitats for a diverse range of plant and animal species. In addition, they serve as natural filters, effectively eliminating contaminants from runoff prior to its entry into streams and rivers. In addition, wetlands and riparian zones play a crucial role in regulating the flow of streams, hence reducing the likelihood of floods. The destruction of these habitats might result in reductions in species numbers and disturb the intricate ecological equilibrium within the watershed.

4. Socio-Economic Implications: The repercussions of a deteriorated urban watershed go beyond environmental considerations. Inadequate water quality can present substantial threats to public health, resulting in escalated healthcare expenses and a deterioration in the general well-being of communities (Wang et al., 2008). Flooding disasters can result in significant financial losses as a result of property damage, relocation of individuals, and disruption of enterprises (Merten et al., 2013). Moreover, the deterioration of natural areas in urban watersheds might restrict recreational possibilities and diminish the aesthetic and cultural significance of these regions. Residents can engage in recreational activities, find relaxation, and establish a connection with nature in healthy urban watersheds.

Strategies for reducing or preventing negative impacts

To address the negative impacts of development on urban watersheds, comprehensive and integrated management strategies are essential. These include:

- **Green Infrastructure**

Implementing green infrastructure such as green roofs, permeable pavements, and rain gardens can significantly reduce runoff and improve water quality. Green roofs, for example, absorb rainfall, reducing the amount of stormwater runoff and lowering the risk of flooding. Permeable pavements allow water to infiltrate through the surface and into the underlying soil, thereby reducing surface runoff and promoting groundwater recharge (Fletcher et al., 2015). Rain gardens, which are shallow, vegetated basins, can capture and filter stormwater, removing pollutants before they reach waterways (Dietz, 2007).

- **Riparian Buffer Zones**

Preserving and restoring riparian buffer zones along waterways is crucial for protecting water quality and providing habitat for wildlife. Riparian buffers are strips of vegetation along streams and rivers that help filter out pollutants, stabilize stream banks, and provide essential habitat for aquatic and terrestrial species. These buffers act as natural barriers that intercept runoff, trapping sediments, and absorbing nutrients and other pollutants (Naiman & Décamps, 1997). Additionally, riparian zones enhance the ecological health of watersheds by supporting biodiversity and maintaining the integrity of aquatic habitats.

- **Sustainable Urban Planning**

Incorporating watershed protection into urban planning processes ensures that development is balanced with the preservation of natural resources. Sustainable urban planning involves integrating land use planning with water management practices to minimize the environmental footprint of urban development. Strategies include zoning regulations that limit impervious surface cover, promoting higher-density development to reduce sprawl, and preserving green spaces and wetlands within urban areas (Berke & Manta, 1999). These measures help maintain the natural hydrology of watersheds and protect water quality.

- **Public Education and Involvement**

Engaging the community in watershed protection efforts through education and participatory initiatives can foster a sense of stewardship and support for sustainable practices. Public education campaigns can raise awareness about the importance of healthy watersheds and the impacts of urban development on water quality and ecosystem health. Community involvement initiatives, such as citizen science projects, watershed clean-up events, and volunteer monitoring programs, empower residents to take an active role in protecting their local watersheds (Ryan et al., 2001). Building a knowledgeable and engaged community is essential for the long-term success of watershed management efforts.

Conclusion

Urban watersheds are critical for sustaining the environmental health and infrastructure of metropolitan areas. These watersheds perform vital functions, including water purification, flood control, and providing habitats for diverse species, which are essential for maintaining ecological balance and supporting urban biodiversity. However, urban development significantly impacts these watersheds, often leading to water quality degradation, increased flooding, habitat destruction, and various socio-economic challenges. As urban areas expand, the conversion of natural landscapes to impervious surfaces such as roads and buildings reduces the land's capacity to absorb water. This results in heightened runoff, increased peak flows, and greater pollutant loads entering water bodies. The disruption of natural

hydrological processes leads to a host of environmental problems, including degraded water quality and heightened flood risks. Moreover, the loss of vegetation and natural habitats diminishes biodiversity and the ecological resilience of watersheds. Overall, the sustainable management and rehabilitation of urban watersheds are vital for ensuring the well-being and resilience of urban environments. By adopting comprehensive strategies that integrate ecological, social, and economic considerations, cities can mitigate the adverse effects of urbanization on watersheds, promote environmental sustainability, and enhance the quality of life for urban residents.

Recommendations

Based on the study the following recommendations are made:

1. There should be the adoption of green roofs and permeable pavements to reduce surface runoff and promote groundwater recharge.
2. There should be the establishment of rain gardens to capture and filter stormwater, removing pollutants before they reach waterways.
3. There should be the maintenance and restoration of strips of vegetation along streams and rivers to filter out pollutants, stabilize stream banks, and provide habitats for wildlife.
4. There should be support for the biodiversity and ecological health of watersheds by enhancing riparian zones.
5. There should be integration of watershed protection into land use planning to minimize the environmental impact of urban development.
6. There should be the implementation of zoning regulations that limit impervious surface cover and promote higher-density development to reduce sprawl.
7. There should be the preservation of green spaces and wetlands within urban areas to maintain natural hydrology and protect water quality.
8. There should be public education campaigns to raise awareness about the importance of healthy watersheds and the impacts of urban development on water quality and ecosystem health.
9. There should be the development and implementation of integrated watershed management plans that consider ecological, social, and economic factors to ensure the sustainable management and rehabilitation of urban watersheds.
10. There should be encouragement of collaboration among government agencies, non-profit organizations, researchers, and the community to address watershed management challenges and promote environmental sustainability.

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