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**Evaluating pollution rates in Saigon River**

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***ABSTRACT***

As part of Ho Chi Minh City's economy, the Saigon River remains a historical landmark and a vital waterway for socio-economic activities in and around Vietnam. However, the river has experienced dismal conditions in the past decades due to rapid industrialization, urban encroachment, and poor waste management practices. As a result, this phenomenon endangers aquatic ecosystems while exposing the entire population to severe health risks and disaster damage to the livelihoods of people who rely on the river for fishing, agriculture, and recreation.

This research thoroughly examines the current pollution state of the Saigon River through several key water quality indicators, notably Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and heavy metals concentration. Moreover, the research will evaluate the ecological profile of the river in toto to facilitate informing policymakers and stakeholders on the needs for judicious and immediate action for targeted interventions and sustainable efforts toward the restoration of the river's health and people's health.

**A. Introduction**

The Saigon River is a vital channel for southern Vietnam, supplying drinking water, transportation, irrigation, and economic support for city dwellers. However, it has passed alarming levels of pollution owing to rapid urbanization and industrial growth along its two banks and poor control of waste discharge. Because of that, the following project assesses pollution in this river by analyzing water quality, considering contamination sources, and proposing the necessary actionable solutions. Moreover, this project addresses this issue considering protecting public health, biodiversity, and sustainable development in one of the most populous regions of Vietnam.

**B. literature review**

The Saigon River is important to Ho Chi Minh City, and it is one of the most polluted rivers. Therefore, pollution from industries, homes, and agriculture significantly contributes to this heavy burden. Additionally, industries discharge heavy metals and antibiotic residues; houses contribute organic nutrients and pathogens, resulting in a complicated picture for the effective management of the water quality. Moreover, it makes worse the seasonality of fluctuation in contaminant levels when these problems are to be handled with respect to sustainability against health challenges.

During the wet season in Saigon River, there are periods of maximum turbidities, BOD5, and nutrients. Moreover, during the dry season, the decrease in these parameters is counterbalanced by increases in dissolved oxygen and some heavy metals. Additionally, this indicates that the river is capable of dynamic ecosystem shifts and climate effects on water quality. Therefore, pollution impacts both aquatic organisms and human health, presenting serious environmental and public health challenges. The urgency of this situation necessitates the implementation of intensive pollution control measures. Furthermore, it is imperative to establish continuous monitoring systems to assess the health of the river and its impact on public health. Such proactive approaches are essential for mitigating the adverse effects of pollution and ensuring the sustainability of the aquatic ecosystem.

**C. Rationale**

In the era of globalization, there is an escalating requirement for clean water in Ho Chi Minh City, resulting from the rapid population growth. As a result, this alarming circumstance poses several public health risks, damages the local ecosystem, and threatens the socioeconomics of the community depending on the Saigon River. Thus, it is essential to evaluate water rates to assess the status of water resources and to form efficient strategies for their sustainable future use.

**Academic research questions:**

**1. What are the primary sources of pollution in the Saigon River, and how do their contributions vary spatially and temporally across different sections of the river? (**This question seeks to address the root causes of pollution.)

**2. How do the levels of key pollutants in the Saigon River compared to national and international water quality standards, and what implications does this have for public health?** (This question addresses the examination of the health implications of pollution.)

**3. What are the socio-economic impacts of Saigon River pollution on local fishing communities, and how do these impacts affect their livelihood and food security?** (This question investigates the socio-economic consequences of pollution.)

**4. How effective are existing regulatory frameworks and policies in managing pollution in the Saigon River, and what gaps exist in their implications?** (This question evaluates the effectiveness of existing policies and regulations.)

As a result, following these essential questions of research on Saigon River pollution-they address fundamental environmental and human health issues. Moreover, these great questions will identify pollution sources and compare them to standards for water quality against which interventions will be initiated. In addition, socio-economic implications to fishing communities portray a need for livelihoods that are sustainable to those communities. Therefore, checking regulatory efficacy will expose deficiencies in controlling pollution. Thus, one could have an integrated approach to pollution and solutions that will benefit the river and its communities.

This study claims that microplastic pollution in the Saigon River negatively impacts water quality. The hypothesis being evaluated is that increased water levels correlate with higher microplastic concentrations due to urban runoff. Statistical regression and machine learning models will analyze this relationship, while Geographic Information Systems (GIS) will identify pollution hotspots. This comprehensive approach aims to elucidate the interaction between hydrological changes and microplastic distribution in the river ecosystem.

**D. Method and Design**

**1. Participants**

Nguyen Duc Anh, a middle-aged male of 40 living in a nearby house with his wife and two children, has been in employment at a textile factory located along the Saigon River for the past 15 years. Nowadays, he’s extremely worried about the route that takes his water source - the Saigon River. Suprisingly, in the past decade, the cleanliness of the river has greatly deteriorated. He has seen the direct discharge of industrial waste into the river and observed that the waterborne diseases in the community seem to be increasing.

Anh is an active participant in the research study and provided valuable information during the in-depth interviews. Moreover, he elucidated his observations regarding aquatic quality improvement and the effects of this water on his family's health. In addition, Anh spoke about how factory workers are unable to meet environmental regulations and face significant challenges due to nonexistent waste management practices at his workplace. As a result, his first-hand experiences and comprehensive narratives have helped researchers understand the industrial contributions to water pollution and the socio-economic factors that affect the local community. Thus, the study gains a very important perspective regarding the human dimension of environmental degradation from Anh's narrative as that of the community that is supposed to inform the solutions in addressing pollution in the Saigon River.

**2. Data collection**

Various methods were employed to collect the data for this study, namely, field sampling, surveys, and observations. In addition, these water samples were taken from numerous places along the Saigon River, the focus being on those areas which are involved in agricultural, industrial, and residential activities. The samples were taken in the dry as well as in the rainy season to register the seasonal variations of the water quality.

**Field Sampling:** Water samples were collected from twelve locations along the river, including areas affected by agriculture, industry, residential activities, and regions with minimal impact. The samples were taken from a depth of 20-30 cm below the surface to avoid any surface scum. At each site, three samples were gathered (two from each side and one from the center) and then combined into a 10 L container. Sterilized bottles were used for storing the samples for laboratory analysis. This approach ensured a thorough evaluation of water quality across various sections of the river.

**In-Depth Interviews:** Interviews with local government officials and environmental experts provided knowledgeable perspectives on the regulations and management practices affecting the Saigon River. These discussions offered a deeper understanding of the existing policies, the challenges in enforcement, and the effectiveness of current pollution control measures. The insights gained were essential for identifying gaps in current strategies and potential areas for enhancement.

**Group Discussions:** Community members came together in groups to discuss shared issues and observations regarding water pollution. These discussions fostered a collective understanding of the problem and emphasized the community's priorities and concerns. They also encouraged the sharing of ideas and solutions, promoting a sense of community involvement and ownership in tackling water pollution.

**Observations:** Direct observations were conducted to identify visible signs of pollution, such as floating debris.

**3. Analysis**

**Descriptive Analysis:** This section involved detailing the data collected from questionnaires and observations made through surveys to provide an overall understanding of the water pollution issue in the Saigon River. Key measurements such as pH, temperature, dissolved oxygen (DO), chemical oxygen demand (COD), and biological oxygen demand (BOD) were taken at four out of five locations across three different seasons. These assessments offered a thorough insight into water quality and helped pinpoint the most contaminated areas along with the seasonal fluctuations in pollution levels.

**Thematic Analysis:** The qualitative data gathered from interviews and group discussions were examined to uncover recurring themes and patterns related to pollution sources and their impacts. This approach enabled the study to explore the socio-economic factors that contribute to water pollution more deeply. By analyzing these themes, the research illustrated how various human activities, including industrial discharges, agricultural runoff, and household waste, are the main contributors to water pollution. Additionally, this analysis shed light on the community's views and worries about the river's water quality.

**Multivariate Statistical Techniques:** Principal Component Analysis (PCA) and Cluster Analysis (CA) were utilized to identify the primary factors influencing water quality. PCA was instrumental in simplifying the data, highlighting the key variables that account for the most variation in water quality. Subsequently, Cluster Analysis grouped the sampling sites based on similarities in their water quality parameters. This methodology enabled the study to classify different sections of the river according to their pollution levels and pinpoint specific areas that need focused intervention. By employing these sophisticated statistical methods, the research offered a more detailed understanding of the factors affecting water quality and the spatial distribution of pollution.

**E. Findings**

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**F. Conclusion and Significance**

**1. Significance of the results and their implications**

The analysis of water pollution in the Saigon River has brought to light the crying need for effective management measures to enhance water quality. Additionally, high polluting levels threaten the health of people, especially among the most susceptible populations, such as children and the elderly, and contribute to waterborne diseases. Also, pollution threatens local fisheries, agriculture, and tourism, thus undermining the livelihoods of many people living in this zone. Because of that, addressing these problems would revamp the economy and protect an ecosystem that is essential for biodiversity. Sustainable action and pollution control should also restore ecological balance and ensure the river's health in future years.

The findings emphasize the importance of increased community engagement in water conservation efforts. By educating residents on the sources and effects of water pollution, we can cultivate a sense of responsibility and motivate proactive steps to mitigate pollution. Initiatives led by the community, like clean-up campaigns and monitoring programs, are essential for preserving water quality. Although this study offers important insights into the water pollution challenges facing the Saigon River, it is important to recognize several limitations.

**2. Limitation**

The study's sampling sites were confined to specific areas along the river, which might not fully reflect the overall water quality. Increasing the number of sampling locations and incorporating a wider variety of sites could lead to a more thorough assessment. Moreover, the data collection occurred over a limited time period, which may not capture the full range of seasonal changes in water quality. Long-term monitoring is essential to grasp the temporal dynamics of pollution levels. Although the study identified several pollutants, it did not thoroughly trace all sources of pollution. Further investigation is necessary to identify specific industrial, agricultural, and residential contributors to the pollution. The study mainly concentrated on environmental and health impacts, with less focus on the socio-economic factors that influence pollution. Future research could delve into the socio-economic drivers of pollution and evaluate the effectiveness of policy interventions.

The study utilized existing technology and methods for water quality analysis, which may have limitations in detecting certain pollutants or providing detailed data. Improvements in analytical techniques could enhance the accuracy and breadth of future research. By addressing these limitations and pursuing further investigation, future studies can build on the current findings to create more effective strategies for managing and reducing water pollution in the Saigon River. This ongoing research is crucial for ensuring the health and well-being of the community and the sustainability of the river's ecosystem.

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