International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at http://euroasiapub.org
Vol. 8 Issue 12, December-2018,
ISSN (O): 2249-3905, ISSN(P): 2349-6525 | Impact Factor: 7.196 |

" Comprehensive Study on Water Pollution and Its Impact on Public Health"

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Abstract:

This research paper aims to provide a thorough examination of water pollution and its multifaceted impact on public health. Water pollution is a global concern that affects the quality of water resources essential for human consumption, agriculture, and industrial processes. The paper will explore various sources of water pollution, including industrial discharge, agricultural runoff, and urban wastewater, and assess the pollutants they introduce into water bodies.

Introduction:

Water is an essential resource for human survival. According to the 2016 World Water Development Report released by UNESCO, the global use of freshwater has increased six-fold in the past 100 years and has been growing by about 1% per year since the 1980s. With the increase of water consumption, water quality is facing severe challenges. Industrialization, agricultural production, and urban life have resulted in the degradation and pollution of the environment, adversely affecting the water bodies (rivers and oceans) necessary for life, ultimately affecting human health and sustainable social development (Xu et al., 2012a). Globally, an estimated 80% of industrial and municipal wastewater is discharged into the environment without any prior treatment, with adverse effects on human health and ecosystems. This proportion is higher in the least developed countries, where sanitation and wastewater treatment facilities are severely lacking.

1.1 Sources of Water Pollution:

Water pollution are mainly concentrated in industrialization, agricultural activities, natural factors, and insufficient water supply and sewage treatment facilities. First, industry is the main cause of water pollution, these industries include distillery industry, tannery industry, pulp and paper industry, textile industry, food industry, iron and steel industry, nuclear industry and so on. Various toxic chemicals, organic and inorganic substances, toxic solvents and volatile organic chemicals may be released in industrial production. If these wastes are released into aquatic

ecosystems without adequate treatment, they will cause water pollution (Chowdhary et al., 2010). Arsenic, cadmium, and chromium are vital pollutants discharged in wastewater, and the industrial sector is a significant contributor to harmful pollutants ,).

In addition, water pollution caused by industrialization is also greatly affected by foreign direct investment. Industrial water pollution in less developed countries is positively correlated with foreign direct investment (Jorgenson, 2009). Second, water pollution is closely related to agriculture. Pesticides, nitrogen fertilizers and organic farm wastes from agriculture are significant causes of water pollution (RCEP, 1979). Agricultural activities will contaminate the water with nitrates, phosphorus, pesticides, soil sediments, salts and pathogens (Parris, 2011). Furthermore, agriculture has severely damaged all freshwater systems in their pristine state (Moss, 2008). Untreated or partially treated wastewater is widely used for irrigation in water-scarce regions of developing countries, including China and India, and the presence of pollutants in sewage poses risks to the environment and health. Taking China as an example, the imbalance in the quantity and quality of surface water resources has led to the long-term use of wastewater irrigation in some areas in developing countries to meet the water demand of agricultural production, resulting in serious agricultural land and food pollution, pesticide residues and heavy metal pollution threatening food safety and Human Health (Lu et al., 2015). Pesticides have an adverse impact on health through drinking water. Comparing pesticide use with health life Expectancy Longitudinal Survey data, it was found that a 10% increase in pesticide use resulted in a 1% increase in the medical disability index over 65 years of age (Lai, 2017). The case of the Musi River in India shows a higher incidence of morbidity in wastewater-irrigated villages than normal-water households. Third, water pollution is related to natural factors. Taking Child Loess Plateau as an example, the concentration of trace elements in water quality is higher than the average world level, and trace elements come from natural weathering and manufacture causes.. The most typical water pollution in the middle part of the loess Plateau is hexavalent chromium pollution, which is caused by the natural environment and human activities. Loess and mudstone are the main sources, and groundwater with high concentrations of hexavalent chromium is also an important factor in surface water.

In parallel with China rapid economic growth, industrialization and urbanization, underinvestment in basic water supply and treatment facilities has led to water pollution, increased incidence of infectious and parasitic diseases, and increased exposure to industrial chemicals, heavy metals and algal toxins (Wu et al., 1999). An econometric model predicts the impact of water purification equipment on water quality and therefore human health. When the proportion of household water treated with water purification equipment is reduced from 100%

to 90%, the expected health benefits are reduced by up to 96%.. When the risk of pretreatment water quality is high, the decline is even more significant (Brown and Clasen, 2012).

To sum up, water pollution results from both human and natural factors. Various human activities will directly affect water quality, including urbanization, population growth, industrial production, climate change, and other factors (Halder and Islam, 2015) and religious activities (Dwivedi et al., 2018). Improper disposal of solid waste, sand, and gravel is also one reason for decreasing water quality .

1.2 Impact of Water Pollution on Human Health:

Unsafe water has severe implications for human health. According to UNESCO 2021 World Water Development Report, about 829,000 people die each year from diarrhea caused by unsafe drinking water, sanitation, and hand hygiene, including nearly 300,000 children under the age of five, representing 5.3 percent of all deaths in this age group. Data from Palestine suggest that people who drink municipal water directly are more likely to suffer from diseases such as diarrhea than those who use desalinated and household-filtered drinking water (Yassin et al., 2006). In a comparative study of tap water, purified water, and bottled water, tap water was an essential source of gastrointestinal disease (Payment et al., 1997). Lack of water and sanitation services also increases the incidence of diseases such as cholera, trachoma, schistosomiasis, and helminthiasis. Data from studies in developing countries show a clear relationship between cholera and contaminated water, and household water treatment and storage can reduce cholera (Gundry et al., 2004). In addition to disease, unsafe drinking water, and poor environmental hygiene can lead to gastrointestinal illness, inhibiting nutrient absorption and malnutrition. These effects are especially pronounced for children.

Purpose of This Paper:

More than two million people worldwide die each year from diarrhoeal diseases, with poor sanitation and unsafe drinking water being the leading cause of nearly 90% of deaths and affecting children the most (United Nations, 2016). More than 50 kinds of diseases are caused by poor drinking water quality, and 80% of diseases and 50% of child deaths are related to poor drinking water quality in the world. However, water pollution causes diarrhea, skin diseases, malnutrition, and even cancer and other diseases related to water pollution. Therefore, it is necessary to study the impact of water pollution on human health, especially disease heterogeneity, and clarify the importance of clean drinking water, which has important theoretical and practical significance for realizing sustainable development goals. Unfortunately, although many kinds of literature focus on water pollution and a particular disease, there is still a

lack of research results that systematically analyze the impact of water pollution on human health and the heterogeneity of diseases. Based on the above background and discussion, this paper focuses on the effect of water pollution on human health and its disease heterogeneity.

Objective:

The overarching objective of this research is to conduct a thorough and multidisciplinary investigation into the impact of water pollution on public health. Through a systematic analysis of water pollutants, their sources, and pathways, we aim to elucidate the direct and indirect consequences of water contamination on human health. The specific objectives include:

Identification and Classification of Water Pollutants:

Assessing the presence of diverse pollutants, such as heavy metals, pesticides, pathogens, and emerging contaminants, in various water sources.

Sources and Pathways Analysis:

Investigating major sources of water pollution, including industrial discharges, agricultural runoff, and urban wastewater, to understand the pathways through which pollutants enter water bodies.

Public Health Impact Assessment:

Analyzing the impact of water pollution on public health, encompassing waterborne diseases, chronic health conditions, and potential long-term health implications.

Epidemiological Investigation:

Examining epidemiological studies to establish associations between water pollution and specific health outcomes, incorporating case studies from regions with documented contamination incidents.

Evaluation of Regulatory Frameworks:

Assessing the effectiveness of existing regulatory frameworks and policies in mitigating water pollution and safeguarding public health.

Technological Solutions for Water Treatment:

Exploring innovative technologies and sustainable practices for water treatment and pollution prevention.

Community Awareness and Engagement Assessment:

Analyzing the role of community awareness and engagement in mitigating water pollution through education programs and grassroots initiatives.

Case Studies Documentation:

Documenting and analyzing case studies from regions with notable water pollution incidents, highlighting challenges, lessons learned, and successful interventions.

Recommendations for Future Action:

Providing recommendations for future research directions, policy improvements, and community-based initiatives to address water pollution and protect public health.

4. Literature Review: Water Pollution and Public Health:

1. Introduction to Water Pollution:

Define water pollution and its significance in the context of public health.

Briefly discuss the major sources of water pollution, including industrial, agricultural, and urban sources.

2. Types of Water Pollutants:

Provide an overview of various types of water pollutants such as heavy metals, pesticides, pathogens, and emerging contaminants.

Summarize key findings from studies identifying and quantifying these pollutants in different water sources.

3. Sources and Pathways of Water Pollution:

Explore literature on major sources of water pollution, including industrial discharges, agricultural runoff, and urban wastewater.

Discuss pathways through which pollutants enter water bodies and potentially affect public health.

4. Impact on Public Health:

Review epidemiological studies linking water pollution to specific health outcomes, including waterborne diseases and chronic health conditions.

Summarize findings on the potential long-term health implications of exposure to water contaminants.

5. Regulatory Frameworks and Policies:

Examine existing regulatory frameworks and policies aimed at controlling water pollution globally.

Evaluate the effectiveness of these frameworks in safeguarding public health and preventing waterborne diseases.

6. Technological Solutions for Water Treatment:

Survey literature on innovative technologies and sustainable practices for water treatment and pollution prevention.

Highlight successful case studies implementing these technologies.

7. Community Awareness and Engagement:

Discuss the role of community awareness and engagement in mitigating water pollution.

Explore studies on the effectiveness of education programs and grassroots initiatives in promoting water quality.

8. Case Studies:

Present and analyze case studies from regions with documented water pollution incidents.

Discuss challenges faced, lessons learned, and successful interventions in addressing water pollution and protecting public health.

9. Gaps in the Current Knowledge:

Identify gaps in the existing literature that your research aims to address.

Emphasize the need for further research in specific areas to enhance our understanding of the complex relationship between water pollution and public health.

5.0 Research Methodology:

1. Research Design:

Type of Study: Explain whether your study is observational, experimental, case-control, or a combination.

Time Frame: Specify the duration of your study, including any temporal considerations.

Scope: Define the geographic and demographic scope of your research.

2. Sampling Strategy:

Population: Describe the target population, such as specific regions, communities, or demographic groups.

Sampling Method: Clarify the method used for selecting samples (e.g., random sampling, stratified sampling).

Sample Size: Justify the chosen sample size and discuss any potential limitations.

3. Data Collection:

Primary Data: Describe the methods for collecting primary data (if applicable), such as surveys, interviews, or field measurements.

Secondary Data: Specify sources for secondary data, such as existing studies, reports, or databases.

Instruments: If using surveys or interviews, detail the instruments employed and their validity and reliability.

4. Variables and Measures:

Independent Variables: Clearly define and describe the independent variables, such as types of water pollutants, pollution sources, and regulatory measures.

Dependent Variables: Specify the dependent variables, including health outcomes and public health indicators.

Operationalization: Explain how each variable is measured or operationalized in your study.

5. Data Analysis:

Statistical Methods: Outline the statistical methods you will use for data analysis (e.g., regression analysis, descriptive statistics).

Software: Specify the statistical software (e.g., SPSS, R) you will use.

Hypotheses: If applicable, state any hypotheses you will test and the expected outcomes.

6. Ethical Considerations:

Informed Consent: Explain how you will obtain informed consent from study participants.

Confidentiality: Address how you will protect the confidentiality of participants' data.

Ethical Approval: If required, discuss the ethical approval process and any ethical concerns.

7. Limitations:

Internal Validity: Acknowledge potential threats to internal validity and how you will address them.

External Validity: Discuss the generalizability of your findings to other populations or settings.

Sampling Bias: Recognize potential biases in your sampling strategy.

8. Pilot Study:

Purpose: If applicable, explain the purpose and outcomes of any pilot study conducted.

Adjustments: Describe any adjustments made to the research design based on pilot study results.

9. Timeline:

Project Timeline: Present a timeline outlining key milestones and the overall duration of the research.

10. Data Management:

Data Collection Procedures: Detail how data will be collected, recorded, and stored.

Data Security: Explain measures taken to ensure the security and integrity of the data.

6.0 Analysis and Discussion:

1. Overview of Findings:

Summary of Results: Provide a concise summary of the key findings from your data analysis.

Descriptive Statistics: Include relevant descriptive statistics to characterize the data.

2. Comparison with Existing Literature:

Link to Literature: Discuss how your findings align with or diverge from existing literature on water pollution and public health.

Consistency and Inconsistencies: Highlight any consistencies or inconsistencies with previous research.

3. Impact on Public Health:

Association with Health Outcomes:Analyze the relationship between water pollution variables and public health outcomes identified in your study.

Magnitude of Effect: Discuss the magnitude of the impact, if applicable.

4. Implications for Regulatory Frameworks:

Effectiveness of Regulations: Evaluate the effectiveness of existing regulatory frameworks in mitigating water pollution based on your findings.

Recommendations for Improvement: Suggest improvements or modifications to current regulatory measures.

5. Technological Solutions and Best Practices:

Efficacy of Technologies: Assess the effectiveness of technological solutions discussed in the literature review.

Applicability: Discuss the practical applicability of these technologies in the context of your study.

6. Community Awareness and Engagement:

Role in Mitigation:Analyze the role of community awareness and engagement in mitigating the impact of water pollution on public health.

Success Factors: Identify factors that contribute to the success or failure of community-based initiatives.

7. Case Studies Comparison:

Lessons Learned: Summarize lessons learned from the case studies presented in the literature.

Relevance to Your Study: Discuss the relevance of these lessons to your specific research context.

8. Addressing Research Objectives:

Objectives Recap: Revisit each research objective and demonstrate how your findings address these objectives.

Contributions to Knowledge: Highlight the contribution your study makes to the existing body of knowledge.

7.0 Results:

1. Descriptive Statistics:

Provide descriptive statistics for key variables, such as concentrations of pollutants, public health indicators, and regulatory measures.

Use measures such as means, standard deviations, and percentiles to summarize the central tendency and variability of the data.

2. Identification of Water Pollutants:

Present the types and concentrations of water pollutants identified in various water sources.

Utilize tables or figures to display the data graphically.

3. Sources and Pathways Analysis:

Detail the contributions of different sources (industrial discharges, agricultural runoff, urban wastewater) to water pollution.

Discuss the predominant pathways through which pollutants enter water bodies.

4. Public Health Impact Assessment:

Display the prevalence of waterborne diseases and the incidence of chronic health conditions in the studied population.

Use statistical measures to quantify the association between water pollution variables and health outcomes.

5. Epidemiological Investigation:

Summarize the findings from epidemiological studies, emphasizing the strength of associations and statistical significance.

Present relevant statistics, such as odds ratios or relative risks.

6. Evaluation of Regulatory Frameworks:

Assess the effectiveness of existing regulatory measures in controlling water pollution.

Highlight compliance rates and any variations across different regions or sectors.

7. Technological Solutions and Best Practices:

Display the effectiveness of various technological solutions in reducing pollutant levels.

Compare the performance of different treatment methods.

8. Community Awareness and Engagement:

Report on the level of community awareness and engagement in water pollution mitigation.

Present survey or interview results on community perceptions and actions.

9. Case Studies Documentation:

Summarize the key findings from case studies, including the challenges faced, interventions implemented, and outcomes achieved.

Use tables or narratives to convey this information.

10. Cross-Sectional and Comparative Analyses:

Conduct cross-sectional analyses to identify patterns and trends in the data.

Perform comparative analyses between different regions, demographic groups, or time periods.

8.0 References:

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