Lecture Notes in Networks and Systems 1608

Abhishek Swaroop
Bal Virdee
Sérgio Duarte Correia
Zdzislaw Polkowski *Editors*

Proceedings of Data Analytics and Management

ICDAM 2025, Volume 8

Springer

Lecture Notes in Networks and Systems 1608

The series "Lecture Notes in Networks and Systems" publishes the latest developments in Networks and Systems—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNNS.

Volumes published in LNNS embrace all aspects and subfields of, as well as new challenges in, Networks and Systems.

The series contains proceedings and edited volumes in systems and networks, spanning the areas of Cyber-Physical Systems, Autonomous Systems, Sensor Networks, Control Systems, Energy Systems, Automotive Systems, Biological Systems, Vehicular Networking and Connected Vehicles, Aerospace Systems, Automation, Manufacturing, Smart Grids, Nonlinear Systems, Power Systems, Robotics, Social Systems, Economic Systems and other. Of particular value to both the contributors and the readership are the short publication timeframe and the worldwide distribution and exposure which enable both a wide and rapid dissemination of research output.

The series covers the theory, applications, and perspectives on the state of the art and future developments relevant to systems and networks, decision making, control, complex processes and related areas, as embedded in the fields of interdisciplinary and applied sciences, engineering, computer science, physics, economics, social, and life sciences, as well as the paradigms and methodologies behind them.

Indexed by SCOPUS, EI Compendex, INSPEC, WTI Frankfurt eG, zbMATH, SCImago.

All books published in the series are submitted for consideration in Web of Science.

For proposals from Asia please contact Aninda Bose (aninda.bose@springer.com).

Abhishek Swaroop · Bal Virdee ·
Sérgio Duarte Correia · Zdzislaw Polkowski
Editors

Proceedings of Data Analytics and Management

ICDAM 2025, Volume 8

Springer

Editors
Abhishek Swaroop
Department of Information Technology
Bhagwan Parshuram Institute of Technology
New Delhi, Delhi, India

Bal Virdee
Centre for Communications Technology
London Metropolitan University
London, UK

Sérgio Duarte Correia
Polytechnic Institute of Portalegre
Escola Superior de Tecnologia Gestão
Portalegre, Portugal

Zdzislaw Polkowski
Jan Wyzykowski University
Polkowice, Poland

ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-3-032-03739-8 ISBN 978-3-032-03740-4 (eBook)
https://doi.org/10.1007/978-3-032-03740-4

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

We hereby are delighted to announce that London Metropolitan University, London, UK, in association with WSG University, Bydgoszcz Poland, Portalegre Polytechnic University, Portugal, Europe; Portalegre Polytechnic University, Portugal, Europe and SGGW Management Institute, Poland, Portugal, has hosted the eagerly awaited and much coveted International Conference on Data Analytics & Management (ICDAM-2025) in Hybrid Mode during June 13–15, 2025. The sixth version of the conference was able to attract a diverse range of engineering practitioners, academicians, scholars, and industry delegates, with the reception of abstracts including more than 7000 authors from different parts of the world. The committee of professionals dedicated to the conference is striving to achieve a high-quality technical program with tracks on data analytics with computer networks. All the tracks chosen for the conference are interrelated and are very famous among the present-day research community. Therefore, a lot of research is happening in the above-mentioned tracks and their related sub-areas. As the name of the conference starts with the word "Data Analytics," it has targeted out-of-the-box ideas, methodologies, applications, expositions, surveys, and presentations helping to upgrade the status of research. More than 2000 full-length papers have been received, among which the contributions are focused on theoretical, computer simulation-based research, and laboratory-scale experiments. Among these manuscripts, 440 papers have been included in the Springer proceedings after a thorough two-stage review and editing process. All the manuscripts submitted to the ICDAM-2025 were peer-reviewed by at least two independent reviewers, who were provided with a detailed review proforma. The comments from the reviewers were communicated to the authors, who incorporated the suggestions in their revised manuscripts. The recommendations from two reviewers were taken into consideration while selecting a manuscript for inclusion in the proceedings. The exhaustiveness of the review process is evident, given the large number of articles received addressing a wide range of research areas. The stringent review process ensured that each published manuscript met the rigorous academic and scientific standards. It is an exalting experience to finally see these elite contributions materialize into ten book volumes as ICDAM-2025 proceedings by Springer entitled "International Conference on Data Analytics & Management." The articles are organized into 10 volumes in some broad categories covering subject matters on machine learning, data mining, data analytics, big data, networks, soft computing, and cloud computing, although given the diverse areas of research reported it might not have been always possible.

ICDAM-2025 invited five keynote speakers and eminent computer science and engineering researchers from around the world. In addition to the plenary sessions on each day of the conference, twenty-two concurrent technical sessions are held on both days to ensure the oral presentation of around 300 accepted papers. Keynote speakers and session chair(s) for each concurrent session have been leading researchers from the thematic area of the session. A technical exhibition is held during the 2 days of the conference, which displays the latest technologies, expositions, ideas, and presentations. The research part

of the conference was organized in a total of 27 unique sessions. These special sessions and international workshops allowed researchers to conduct research in specific areas to present their results in a more focused environment.

An international conference of such magnitude and the release of the ICDAM-2025 proceedings by Springer have been the remarkable outcome of the untiring efforts of the entire organizing team. The success of an event undoubtedly involves the painstaking efforts of several contributors at different stages, dictated by their devotion and sincerity. Fortunately, since the beginning of its journey, ICDAM-2025 has received support and contributions from every corner. We thank all who have wished the best for ICDAM-2025 and contributed by any means toward its success. The edited proceedings volumes by Springer would not have been possible without the perseverance of all the steering, advisory, and technical program committee members.

All the contributing authors thank the organizers of ICDAM-2025 for their interest and exceptional articles. We would also like to thank the authors of the papers for adhering to the schedule and incorporating the review comments. We extend my heartfelt acknowledgment to the authors, peer-reviewers, committee members, and production staff whose diligent work shaped the ICDAM-2025 proceedings. We especially want to thank our dedicated peer reviewers who volunteered for the arduous and tedious step of quality checking and critiquing the submitted manuscripts. We thank my faculty colleagues, Dr. Moolchand Sharma, Dr. Jameel Ahmad, and Dr. Simar Preet Singh, for extending their enormous assistance during the conference. The time spent by them, and the midnight oil burnt is greatly appreciated, for which we will ever remain indebted. The college's management, faculties, administrative, and support staff have constantly been extending their services whenever needed, for which we remain thankful to them.

We would like to express our sincere gratitude to Springer for accepting our proposal to publish the ICDAM-2025 conference proceedings. The support and guidance we received from Mr. Aninda Bose, the acquisition senior editor, were instrumental in making this a reality. We are truly grateful for their assistance and look forward to our continued collaboration.

Convener, ICDAM-2025

Organization

Steering Committee

Patrons

Don MacRaild (Pro-vice Chancellor)	London Metropolitan University
Wioletta Boznańska (Rector)	The Karkonosze State University of Applied Sciences in Jelenia Góra, Poland
Beata Telążka (Vice-rector)	The Karkonosze State University of Applied Sciences in Jelenia Góra, Poland

Honorary Chairs

Vaclav Snasel (Rector)	VSB-Technical University of Ostrava, Czech Republic
Chris Lane	London Metropolitan University

General Chairs

Janusz Kacprzyk	Polish Academy of Sciences, Systems Research Institute, Poland
Karim Ouazzane	London Metropolitan University

Conference Chairs

Vassil Vassilev	London Metropolitan University
Pancham Shukla	Imperial College London
Mak Sharma	Birmingham City University

Conveners

Bal Virdee,	London Metropolitan University
Sérgio Duarte Correia	Politécnico de Portalegre, Portugal

Publication Chairs

Abhishek Swaroop (HoD)	Bhagwan Parshuram Institute of Technology, India
Zdzislaw Polkowski	WSG University, Bydgoszcz, Poland

Technical Program Chairs

Shahram Salekzamankhani	London Metropolitan University
Mohammad Hossein Amirhosseini	University of East London
Richa Sharma	London Metropolitan University
Qicheng Yu,	London Metropolitan University
Preeti Patel	London Metropolitan University
Suresh Chandra Padhy (President)	Poornima University, Jaipur, India
Jameel Ahamed	Maulana Azad National Urdu University, Gachibowli, Hyderabad, India
Moolchand Sharma	Maharaja Agrasen Institute of Technology (GGSIPU), New Delhi

Publicity Chairs

Józef Zaprucki	KPSW, Rector's Proxy for Foreign Affairs, The Karkonosze State University of Applied Sciences in Jelenia Góra, Poland
João Matos-Carvalho	Lusófona University, Portugal
Sandra Fernando	London Metropolitan University
Simar Preet Singh	School of Computer Science Engineering and Technology (SCSET), Bennett University, Greater Noida, Uttar Pradesh, India
Isabel de la Torre Diez	University of Valladolid, Spain
Viktor Sowinski-Mydlarz	London Metropolitan University
Supaprawat Siripipatthanakul	Senior Lecturer at Faculty of Education at Bangkok Thonburi University, Thailand

Contents

Assessing the Health and Environmental Consequences of River Water Pollution on Vulnerable Communities

Pavan Kumar Reddy Yellela, Pratheesh Manikonda, Vamsi Krishna Reddy Bandaru(✉), Dedeepya Sai Gondi, Jayanth Sai Pokkalla, and Jeevithesh Reddy Narravula Reddy

Oakland, USA
bvkrba@gmail.com, sai.gondi@ieee.org

Abstract. River water pollution has become a severe threat to the ecosystem in general and also for the human health in the communities that depend on that water for drinking, agriculture and domestic use. Deteriorating water quality in many areas is caused by contaminants such as heavy metals, industrial effluents, agricultural runoff, and pathogens that cause health risk. In this study, this implication is carried out by examining the major river water pollution types, their sources as well as how they directly and indirectly affect communities. From extensive review of case studies in various geographical region, we analyze the relationship of contamination levels and incidence of waterborne diseases, chronic illness and other health consequences. Furthermore, this paper studies the socio-economic implications of water pollution such as the number of people affected by a decrease in healthcare efficiency, economic productivity losses and inequality in access to and quality of water. We present key mitigation strategies including the use of advanced water treatment measures, stringent regulatory policies as well as community based interventions that can lead to reduction in pollution levels and safeguarding of public health. The major message of this research is the great importance of interdisciplinary cooperation between environmental scientists, policymakers and local communities to conserve the water resources in sustainable ways. Holistic approaches and proactive measures to address river water pollution are essential to make the future healthy, and to protect future generation of aquatic ecosystem.

Keywords: River water pollution · public health · water contamination · waterborne diseases · environmental sustainability · pollution mitigation · heavy metals · water treatment

1 Introduction

Global water pollution of river is a major environmental problem that is affecting the ecosystem and human health. In fact, rivers are often responsible for delivering pollutants from different sources [1]. Could be chemical contaminants such as heavy metals,

P.K.R. Yellela, P. Manikonda, V.K.R. Bandaru, D.S. Gondi, J.S. Pokkalla and J.R.N. Reddy—Independent Researcher.

A. Swaroop et al. (Eds.): ICDAM 2025, LNNS 1608, pp. 1–10, 2026.
https://doi.org/10.1007/978-3-032-03740-4_1

pesticides, industrial waste, or biological contaminants like pathogens, or algal bloom. All these can cause pollution in rivers and lead to degradation of water. Contamination occurs differently in different parts of the world, and can be severe from industrial activity or poor wastewater treatment in some places, while elsewhere it is caused by agricultural runoff and urban development. Nevertheless, local perspectives also matter as many communities near dirty rivers are near and experience both direct health and social economy challenges. Reasons to understand the health impact of river water pollution include. A woefully insufficient number of data exist regarding the number of individuals affected by such problems, as well as the nature and extent of pollution in river systems; however, contamination of river systems can result in a variety of health problems ranging from gastrointestinal diseases from pathogens to chronic illnesses associated with exposure to toxic chemicals. By studying these impacts, we can better comprehend how pollution affects the health of the public and design more function principles to control [2].

Given that affected communities are often highly vulnerable to the adverse health effects of polluted water, this study is relevant to them. This study will lead to highlighting how dealing with pollution and water quality problem is crucial to protect public health and keep community well being. The main aims of this paper is to assess the health impacts generated by river water pollution. It involves identifying and analyzing the particular health problems that communities share with rivers that are polluted. The paper tries to highlight the particular difficulties and vulnerability that these communities experience and how river pollution affects thet. Eventually, the anticipated results of these sets of objectives will provide invaluable insights into the relationship between water pollution and health outcomes so as to influence policies and practices designed to limit pollution and promote public health.

Pollution of river waters has serious impact on public health, especially in populations that depend on these water sources for drinking, agriculture as well as sanitation. Heavy metals, pesticides, industrial effluents and other contaminants can cause many kinds of health problems from simple gastrointestinal infections to chronic cancer. This paper examines health impacts of river water pollution and provides a policy and community level impact assessment. In the light of the operating case studies and the existing research, we highlight the urgent need for the improved water management practices and devised health interventions to guard vulnerable populace [3]**.**

The issue of pollution of river systems is becoming a critical issue particularly to the health of the communities in proximity to the water sources. Chemical runoff, untreated sewage and industrial discharges pollute water resulting in serious risk to human health. This paper studies the impact that river water pollution has on the health of the communities involved in a more in depth analysis. The paper examines the current situation of how prevalent waterborne diseases are, what the long term effects are of toxic substance exposure and how are these things affecting the burden of the public health systems. Given these impacts, a key first step is to understand what they are. Although industrialization and urbanization are continuing to increase, river systems are increasingly being polluted, posing rising health problems for the affected communities. pollutants can be transported to the river water and can cause diseases ranging from acute to chronic on human health [4]. The objective of this paper is to perform a broad and exhaustive

evaluation of the impact structure of river water pollution on community well-being, whereby the determinant are the substances contaminating river water. Optimal planning and development of public health strategies for improved water quality depend on the comprehensive understanding of water quality problems that can be attained by analyzing data pertaining to disease incidence, pollutant exposure, as well as environmental health

2 Literature Review

Industry involvement in river pollution is not new, and many instances have shown how the pollution of the river has severe negative effects not only on environment but on the lives of humans as well. River pollution has historically been caused by industrialization and urbanization. For example, rivers in many industrialized nations were extremely polluted with industrial waste during the Industrial Revolution so severely damaging ecological and public health consequences. There are many historic cases, such as the pollution of the Thames River in London and in the Cuyahoga River in Cleveland which famously caught fire in 1969 due to very high levels of polluting [5]. The story of these historical events speaks to the fact of river pollution going back long in history and raises its importance to put in place effective measures aimed at management of pollution and environmental protection. There are a vast number of pollutants that can enter into a river, which are generally chemical and biological.

The source contaminants are those heavy metals, like lead, mercury and cadmium, often from industrial discharges, mining operation, and improper waste disposal. Another chemical pollutant, another major contributor to both surface and groundwater contamination, is pesticides from industrial runoff. On the other hand, biological contaminant includes pathogens such as bacteria, viruses, and parasites that when present in drinking water can cause diseases [6]. Another form of biological pollution includes algal blooms, which are generally propelled by nutrient runoff and produce toxins that are toxic to both marine life and people. Knowing about these types of pollutants is important in order to evaluate health impacts from them as well as to develop solutions for controlling pollution. River pollution can have diverse acute and chronic health effects. Short term exposure to very high levels of pollutants can cause acute health effect including gastrointestinal disease, respiratory illness, and skin infection.

Figure 1 is the distribution of rivers and sampling points across Shenzhen to represent the locations of monitoring water under the condition. It depicts the major river systems and their tributaries and indicates sampling points located along the course of the river systems. The areas of immediate concern are emphasized in the figure by highlighting clusters of sampling sites in which water quality evaluations are frequently carried out [7]. This distribution enables the complete evaluation of the river water quality and pollution levels in Shenzhen, and it will help us to get a picture of the environmental and public health impacts over the entire city.

However, chronic health effects take longer to develop in those exposed to lower levels of contaminants for longer periods of time. Heavy metals like lead or mercury can cause serious health problems, for example, such as cancer, neurological disorders, and kidney damage when it is exposed chronically. Also, biological contaminants can cause

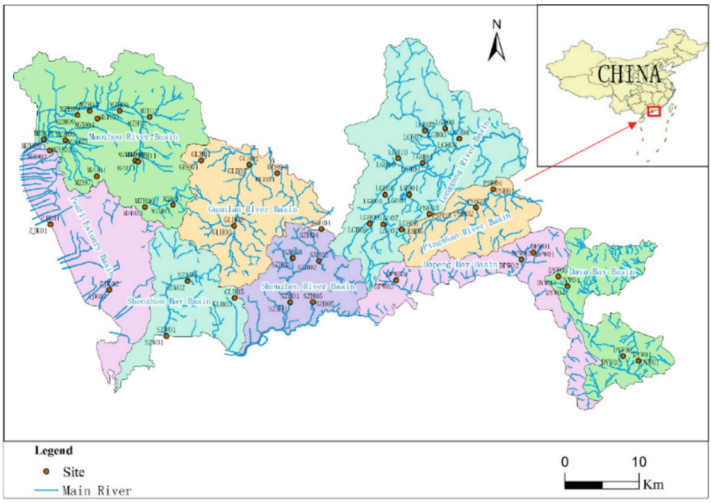

Fig. 1. Distribution of rivers and sampling points in Shenzhen.

long term health problems from repeated infections or chronic disease. It is important to understand the specific diseases and conditions that are related to river pollution in order to address public health concerns and to design and implement good interventions. Research on affected communities has been done and is very useful in terms of research into the real affects of river pollution on real communities. The case studies from a number of different regions show different ways of how pollution impacts the local people. For example, studies have revealed that residents in the vicinity of heavily polluted rivers frequently have higher rates of water borne diseases, higher healthcare costs, and more socio-economic issues. Comparing health impacts in various regions will allow you to better understand patterns and variations of the area, as well as common issues as well as unique local factors. The literature review will consider these case studies to understand the river pollution and its impacts on the community for both policy and practice (Table 1).

Table 1. Notable Historical Cases of River Pollution and Their Impacts

River	Location	Cause of Pollution	Environmental Impact	Health Impact	Notable Event
Thames River	London, UK	Industrial waste, sewage	Oxygen depletion, biodiversity loss	Cholera outbreaks, waterborne diseases	The Great Stink (1858)
Cuyahoga River	Cleveland, USA	Industrial waste, oil spills	Severe water contamination, fires	Respiratory illnesses, toxic exposure	River caught fire (1969)

(*continued*)

Table 1. (*continued*)

River	Location	Cause of Pollution	Environmental Impact	Health Impact	Notable Event
Ganges River	India	Religious offerings, industrial effluents	High microbial contamination, toxic waste	High rates of waterborne diseases, cancer risks	High coliform bacteria levels
Yangtze River	China	Industrial discharge, agricultural runoff	Loss of aquatic life, sediment pollution	Heavy metal poisoning, gastrointestinal issues	Rising mercury contamination
Yamuna River	India	Sewage, industrial waste	Severe pollution, foaming water	Increased cases of dysentery and skin diseases	High ammonia levels detected
Mississippi River	USA	Agricultural runoff, industrial discharge	Dead zones, algal blooms	Increased nitrate poisoning, respiratory issues	Gulf of Mexico dead zone

3 Methodology

Perfect study design to assess the health impacts of river water pollution can build or destroy the results and conclusion drawn. The design of a cross sectional study is often used to survey the status of populations that is caught by the river pollution at a specific time interval. The design also permits the concomitant collection of data on water quality and health outcome, which gives a summary of the situation as a whole. Instead, a longitudinal study design could be adopted to see time changes and determine how being exposed to polluted river water affects health over a prolonged period. In particular, longitudinal studies are important for understanding chronic health effects and effectiveness of given intervention measures over long term basis. This data collection consists of information on water quality and health outcomes [8].

Sampling methods for water quality include sampling of the river from different parts along the river to determine contamination levels. Samples of these pollutants are analyzed for heavy metals, pesticides and biological material. Data about health conditions and health status are collected through surveys, interviews, and medical records to describe how many residents have the disease or health condition. Also, more sophisticated methods such as multivariate analysis may be utilized to eliminate confounding variables and determine the most important predictors of such health impacts. The case study selection requires the selection of areas that represent the broader population who are exposed to river pollution. The presence of data, the severity of pollution and the health impacts are some criteria for how to select. The issue can be better understood

in communities with different levels of pollution and health outcomes. Furthermore, the case studies should represent diverse experiences and condition, and that should be taken into account, factors like population size, demographic characteristic, and geographical location. The study has selected case study communities in such a careful way that the insights derived are not only applicable to the studied areas but also to the similar contexts elsewhere.

The analysis of water quality gives a critical information of the pollution level encountered in the studied rivers. The river water water test the types and concentration of pollutant in the water such as heavy metals (lead, mercury and cadmium), pesticides, biological contaminant (bacteria, viruses) Such as, it can be found that there are high levels of heavy metals for example, in industrial areas or high concentrations of pesticides for example, in agricultural areas. These results could then be compared to accepted safety standards and their results could provide some indication about the severity of contamination and how potentially a risk to human health might be. Finally, these findings help specify which pollutants to concentrate on for further scrutiny and indicate which pollutants, if any, are present in excess of regulatory limits [9, 10]. The health data obtained from the affected communities is able to reveal the frequency of diseases and health conditions that relate to river pollution.

Surveys and medical records expose the patterns of a condition like gastrointestinal infection, lung problems and chronic conditions like cancer or neurological disorder. This data is analyzed to show how these health problems occur in communities exposed to air polluted river water. In addition, comparing these health outcomes with water quality data allows for one to identify potential connections between specific pollutants and specific health conditions. For instance, blood and excretions from animals and people living nearby may be present at elevated levels in the water, which can lead to an increase in episodes of gastrointestinal diseases.

Socioeconomically, river pollution goes beyond health effects to have huge impacts. There is a great concern about the increased healthcare costs, since the communities that suffer pollution related health issues usually associate with more treatment and health service expenses. It also can cause loss of productivity through illness and reduced ability to work with an impact on the local economy [11]. And the psychological and social effects for the residents are also deep and profound. Environment pollution can bring stress, anxiety and feeling helpless which affects your quality of life. Community resistance to health problems and economic hardships may generate social tensions or may diminish community social cohesion. Impacts such as these are emphasized as broader effects of river pollution and need demand for multi disciplinary approach to tackle health and socioeconomic challenges

4 Case Studies

The case studies also make a detailed analysis of a particular community that is influenced by river pollution. Given that the communities selected for the research experience unique health impacts in addition to engaging in different strategies to resolve the issues, the research seeks to identify representative case studies. This extensive study revolves around looking into how varying levels of pollution have affected health outcomes and the efficacy of different mitigation activities that have been carried out by the communities.

Learning about these specific cases provides some lessons on the practical difficulties and successes of attempting to reduce river pollution and these health impacts [12]. The case studies show how to implement these effective pollution management and health protection strategies. Models for other areas confronted with the same challenge can be successful community initiatives such as local clean-up projects, health education programs, and partnership work with environmental organizations. Through identification of these effective strategies, they provide insight into what is best practice for reduction of pollution and enhancement of public health [13]. These case studies provide valuable lessons that can be applied to future interventions and used in further development of policies and programs suitable for addressing these problems.

Further research should look into specific areas to examine and tackle the issue of river pollution and its health impacts. It involves studying pollution source and health change and new technologies and methodologies for pollution monitoring and health assessment. Further, there is a need for more longitudinal studies that follow long term health outcomes and the effect of interventions over time. Based on the findings and lessons learned, certain policy recommendations to enhance pollution control and health outcomes [14] can be made. The policy changes that were suggested included stricter regulations on industrial discharges, better wastewater treatment standards and increase in funding for pollution research and public health. These policies are implemented through collaboration between government agencies, NGOs and local communities, particularly, as collaboration between stakeholders is crucial for implementation of these types of policies and addressing the needs of affected populations [15] (Table 2).

Table 2 Case Studies on River Pollution and Health Impacts

Community/Region	River Affected	Primary Pollution Sources	Health Impacts	Mitigation Strategies Implemented	Key Lessons Learned
Flint, Michigan, USA	Flint River	Industrial waste, lead contamination	Lead poisoning, neurological disorders, gastrointestinal issues	Water treatment reforms, public awareness campaigns, policy changes	Importance of stringent water quality regulations
Kanpur, India	Ganges River	Industrial discharge, tannery waste	Skin diseases, respiratory issues, gastrointestinal infections	Effluent treatment plants, stricter regulations, community clean-ups	Need for industry accountability and waste management
Jakarta, Indonesia	Ciliwung River	Domestic sewage, plastic waste	Waterborne diseases, increased hospitalization rates	River clean-up projects, waste segregation programs, NGO involvement	Community engagement in waste management is crucial

(*continued*)

Table 2 (*continued*)

Community/Region	River Affected	Primary Pollution Sources	Health Impacts	Mitigation Strategies Implemented	Key Lessons Learned
São Paulo, Brazil	Tietê River	Industrial pollution, sewage overflow	High rates of diarrhea, mosquito-borne diseases	Government-led pollution control programs, improved wastewater treatment	Integrated water resource management is essential
Nairobi, Kenya	Nairobi River	Urban waste, heavy metals	Increased cases of cholera, typhoid, heavy metal poisoning	Public health education, better sanitation infrastructure, NGO support	Community-driven sanitation improvements matter
Shanghai, China	Huangpu River	Industrial effluents, agricultural runoff	Cancer clusters, liver and kidney diseases	Strict environmental policies, enhanced monitoring, advanced filtration systems	Technological innovations improve pollution control

5 Conclusion

Despite attempts, the river water pollution is still a serious environmental and public health problem, with overwhelming consequences for human well-being, aquatic ecosystems and socio-economic stability. Water quality is adversely affected very badly due to presence of heavy metals, industrial effluents, agricultural runoff and microbial pathogens resulting into severe health hazard including water borne diseases and chronic illnesses. Also our study illustrates the complex relation of water contamination with public health and it suggests the urgent necessity a quick and efficient intervention strategies.

To mitigate river water pollution, we must engage in a multi-faceted, technology, stringent environmental policies and community engagement. Fortunately, advanced water treatment technologies such as filtration systems, bioremediation and nanotechnology based solutions could make tremendous improvements in water quality. Another aspect surrounding the issue involves enforcing strict industrial regulations as well as promoting sustainable agricultural methods that will eventually reduce the discharge of pollutants into the water bodies.

It is critical for the role of policymakers, researchers and local communities in developing sustainable water management practices. Thus, measures of short time scale, which are only reactive, must be replaced by the measures of long time scale, which are collective and proactive, aimed at protecting water resources from further deterioration.

The access to clean and safe water is fundamental human right and necessary for the achievement of sustainable development and environmental conservation.

6 Future Directions

Although much has been learned concerning and addressed in river water pollution, there still are innovative approaches which can be further researched and developed. Can Artificial Intelligence (AI), and Machine Learning be brought in on water quality monitoring, which can help in the real time detection and prediction of pollution trends for better proactive mitigation measure. Large scale implementation of such water treatment technologies as bio based filtration systems and advanced oxidation processes are possible and a focus for cost effective development and eco friendly technologies.

Long term health consequences of chronic exposure to water contaminant(s), i.e. heavy metals and emerging contaminants such as pharmaceutical residues and micro plastics need to be investigated further. It will also explain and more comprehensively explain the cumulative effects of multiple pollution on health and ecosystems and how best to intervene to manage them.

There is also a critical need for cross sectoral collaboration amongst relevant government, research institution and private organization to develop water management policies and technologies for effective innovations. It's important to promote community based initiatives such as citizen science programs and participatory water governance for public awareness and community involvement in pollution control efforts.

In the end, future work should make clear the socio-economic consequence of water pollution and how this affects agricultural productivity, fisheries as well as rural well being. If we start thinking holistically and interdisciplinarily, we can find ways to alleviate river water pollution and guard this vital resource from the existential threat it faces from the deliberate pollution causing deadly microbes that continue to operate today, now and forever.

References

1. Lin, L., Yang, H., Xu, X.: Effects of water pollution on human health and disease heterogeneity: A review. Front. Environ. Sci. **10**, 880246 (2022)
2. Qadri, R., Faiq, M.A.: Freshwater pollution: Effects on aquatic life and human health. In: Fresh Water Pollution Dynamics and Remediation, pp. 15–26 (2020)
3. Kumar, V., Sharma, A., Kumar, R., Bhardwaj, R., Thukral, A.K., Rodrigo-Comino, J.: Assessment of heavy-metal pollution in three different Indian water bodies by combination of multivariate analysis and water pollution indices. Hum. Ecol. Risk Assess. Int. J. **26**(1), 1–16 (2020)
4. Mokarram, M., Saber, A., Sheykhi, V.: Effects of heavy metal contamination on river water quality due to release of industrial effluents. J. Clean. Prod. **277**, 123380 (2020)
5. Ukah, B., Egbueri, J., Unigwe, C., Ubido, O.: Extent of heavy metals pollution and health risk assessment of groundwater in a densely populated industrial area, Lagos, Nigeria. Int. J. Energy and Water Resources. **3**(4), 291–303 (2019)
6. Proshad, R., et al.: Appraisal of heavy metal toxicity in surface water with human health risk by a novel approach: A study on an urban river in vicinity to industrial areas of Bangladesh. Toxin Rev. **40**(4), 803–819 (2021)

7. Fuller, R., et al.: Pollution and health: A progress update. The Lancet Planet. Health. **6**(6), e535–e547 (2022)
8. Liu, Y., et al.: A review of water pollution arising from agriculture and mining activities in Central Asia: Facts, causes and effects. Environ. Pollut. **291**, 118209 (2021)
9. Li, P., Wu, J.: Drinking water quality and public health. Expo. Health. **11**(2), 73–79 (2019)
10. Giri, S.: Water quality prospective in Twenty First Century: Status of water quality in major river basins, contemporary strategies and impediments: A review. Environ. Pollut. **271**, 116332 (2021)
11. Picó, Y., Barceló, D.: Analysis and prevention of microplastics pollution in water: Current perspectives and future directions. ACS Omega. **4**(4), 6709–6719 (2019)
12. Evans, A.E., Mateo-Sagasta, J., Qadir, M., Boelee, E., Ippolito, A.: Agricultural water pollution: Key knowledge gaps and research needs. Curr. Opin. Environ. Sustain. **36**, 20–27 (2019)
13. Keiser, D.A., Kling, C.L., Shapiro, J.S.: The low but uncertain measured benefits of US water quality policy. Proc. Natl. Acad. Sci. **116**(12), 5262–5269 (2019)
14. Tang, W., Pei, Y., Zheng, H., Zhao, Y., Shu, L., Zhang, H.: Twenty years of China's water pollution control: Experiences and challenges. Chemosphere. **295**, 133875 (2022)
15. Carvalho, L., et al.: Protecting and restoring Europe's waters: An analysis of the future development needs of the Water Framework Directive. Sci. Total Environ. **658**, 1228–1238 (2019)
16. Babuji, P., Thirumalaisamy, S., Duraisamy, K., Periyasamy, G.: Human health risks due to exposure to water pollution: A review. Water. **15**(14), 2532 (2023)
17. Bochynska, S., et al.: The impact of water pollution on the health of older people. Maturitas. **185**, 107981 (2024)
18. Gopinathan, P., Subramani, T., Barbosa, S., Yuvaraj, D.: Environmental impact and health risk assessment due to coal mining and utilization. Environ. Geochem. Health. **45**(10), 6915–6922 (2023)
19. Mestanza-Ramón, C., et al.: Assessment of Hg pollution in stream waters and human health risk in areas impacted by mining activities in the Ecuadorian Amazon. Environ. Geochem. Health. **45**(10), 7183–7197 (2023)
20. Agbasi, J.C., et al.: Water pollution indexing and health risk assessment due to PTE ingestion and dermal absorption for nine human populations in Southeast Nigeria. Groundw. Sustain. Dev. **21**, 100921 (2023)
21. Padhiary, M., Kumar, R.: Assessing the environmental impacts of agriculture, industrial operations, and mining on agro-ecosystems. In: Smart Internet of Things for Environment and Healthcare, pp. 107–126. Springer Nature, Cham, Switzerland (2024)

Time-Critical Sepsis Prediction: Advancing Healthcare Analytics Through Deep Learning Architectures

Jeevithesh Reddy Narravula Reddy, Dedeepya Sai Gondi, Pavan Kumar Reddy Yellela, Jayanth Sai Pokkalla(✉), Pratheesh Manikonda, and Vamsi Krishna Reddy Bandaru

Oakland, USA
sai.gondi@ieee.org, Jayanthspokkalla@gmail.com

Abstract. New healthcare predictive analytics are revolutionized in recent years due to the emergence of deep learning techniques, as they provide unprecedented chances of early disease detection and improved patient's outcomes. In this study, we introduce a novel deep learning framework for early sepsis detection, a life threatening condition due to system's excessive reaction to an infection of about 11 million deaths per year. To validate our model, we applied it to comprehensive electronic health records (EHRs) from a multi-hospital diverse dataset including vital signs, laboratory results, medication data, patient demographics and applied a permutation test. Our framework utilizing recurrent neural networks (RNNs) with attention mechanisms exploits recurrent patterns and key relationships in patient data hidden by conventional screening tools. Secondly, the model predicts sepsis onset up to 24 hours before clinical diagnosis with an area under the receiver operating characteristic curve (AUC) of 0.91, sensitivity of 0.85, and specificity of 0.87. Across several patient populations, performance evaluation indicates robust generalizability, and it may be suitable for wide clinical implementation. With preliminary implementation studies showing clinical improvements of 30% when this system is used to alert clinicians to intervene, it is an early warning system allowing clinicians to act early to save sepsis related mortality. A collaborative approach with healthcare providers is taken to address integration challenges of data standardization, model interpretability and adoption of clinical workflow. These findings show that advanced deep learning can be an important breakthrough in sepsis management, providing us with a valuable instrument to defeat this critical and lethal condition earlier with enhanced target binding of therapeutic interventions.

Keywords: Sepsis · Deep Learning · Predictive Analytics · Healthcare · Early Detection · Machine Learning · Patient Outcomes · Electronic Health Records (EHR) · Clinical Decision Support Systems

J.R.N. Reddy, D.S. Gondi, P.K.R. Yellela, J.S. Pokkalla, P. Manikonda and V.K.R. Bandaru—Independent Researcher.

A. Swaroop et al. (Eds.): ICDAM 2025, LNNS 1608, pp. 11–20, 2026.
https://doi.org/10.1007/978-3-032-03740-4_2

1 Introduction

Sepsis is a severe and potentially fatal disease caused when your body responds to an infection. This provokes widespread inflammation in your body and can damage or fail organs—which is deadly if not quickly treated. As such, its rapid onset, and complex nature pose a major challenge to treating and caring for it in healthcare. Rates of sepsis are high and despite progress in the care is a major risk factor for morbidity and mortality worldwide. Early identification and treatment of sepsis is crucially important for its effective management, as the delay of treatment leads to an increase of the risk of the poor outcome.

Early detection in the case of sepsis is paramount. Patients are more likely to survive and the condition is less serious when treatment is started early. Moreover, early intervention can also reduce the potential complications that have been associated with sepsis progression to severe stages [2]. Thus, the priority of healthcare systems seeking to improve patient outcomes and optimise resource utilisation is to enhance the capability to detect sepsis at its earliest stage.

The tool of predictive analytics and deep learning have turned out to be very powerful in the healthcare arena and opened new doors of early sepsis detection. The forecasting of the onset of sepsis is an example of predictive analytics, where the use of statistical techniques and algorithms to analyze the historical and real time data is done to predict the future events. Machine learning is itself divided into deeper learning and this deep learning itself uses neural networks with multiple layers to model in complex patterns and relationships in data. All of these advanced techniques can do is analyze an enormous amount of patient data including vital signs, lab results, electronic health histories, etc. and study these data to see if there are hints about sepsis [3]. Integration of predictive analytics and deep learning into the clinical practice can greatly improve ability of healthcare providers to detect sepsis early and to intervene effectively.

Typically, sepsis detection techniques utilized clinical judgement and tracking of the main physiological signs such as fevers, elevated heart rate, and fluctuations in blood pressure. Blood tests, imaging studies, and physical examinations are standard diagnostic procedures to ascertain an infection is present and, if so, to determine the extent of it. Although fundamental to diagnosing sepsis, these methods often fail due to their reliance on observable symptoms that are not specific and are variable between patients.

Although the early stages of sepsis often have subtle or atypical symptoms, they can be difficult to recognize before the condition becomes more severe. Few current approaches to the detection of sepsis have limitations. Because symptoms can overlap with symptoms of other conditions or remain until the sepsis is into advanced stages, it may take some time for diagnosis using traditional methods [4]. Moreover, these methods may not be effective because the variability in patient response and time to obtain diagnostic tests limits the amount of effect of these methods.

This delay in diagnosis has a high stain onto increased mortality rates and more complicated illnesses, which highlights the necessity for extra forthright techniques of discovery. Using data-driven approaches that are consistent with predictive analytics, patients traveling with sepsis can be easily and efficiently identified before true clinical signs can be detected. Predictive models based on the analysis of high datasets obtained

8. Zhang, X., Guo, L., Xue, Y., Jiang, H., Liu, L., Zhang, Q.: A hybrid covert channel with feedback over mobile networks. In: Security and Privacy in Social Networks and Big Data: 5th International Symposium, SocialSec 2019, Copenhagen, Denmark, 14–17 July 2019, Revised Selected Papers 5, pp. 87–94. Springer, Singapore (2019)
9. Vasudevan, V.A., Tselios, C., Politis, I.: On security against pollution attacks in network coding enabled 5g networks. IEEE Access **8**, 38416–38437 (2020)
10. Ludant, N., Noubir, G.: SigUnder: a stealthy 5G low power attack and defenses. In: In: Proceedings of the 14th ACM Conference on Security and Privacy in Wireless and Mobile Networks, pp. 250–260 (2021)
11. Liang, C., Qiu, K., Zhang, Z., Yang, J., Li, Y., Hu, J.: Towards robust and stealthy communication for wireless intelligent terminals. Int. J. Intell. Syst. **37**(12), 11791–11814 (2022)
12. Jiang, Y.E., Wang, L., Chen, H.H., Shen, X.: Physical layer covert communication in B5G wireless networks—its research, applications, and challenges. Proc. IEEE **112**(1), 47–82 (2024)
13. Zhang, X., Tan, Y.-A., Liang, C., Li, Y., Li, J.: A covert channel over volte via adjusting silence periods. IEEE Access **6**, 9292–9302 (2018)
14. Zhang, X., Zhu, L., Wang, X., Zhang, C., Zhu, H., Tan, Y.-a: A packet-reordering covert channel over VoLTE voice and video traffics. J. Netw. Comput. Appl. **126**, 29–38 (2019)
15. Zhang, X., Pang, L., Guo, L., Li, Y.: Building undetectable covert channels over mobile networks with machine learning. In: Machine Learning for Cyber Security: Third International Conference, ML4CS 2020, Guangzhou, China, 8–10 October 2020, Proceedings, Part I 3, pp. 331–339. Springer, Heidelberg (2020)
16. Kalmbach, M., Gottschlag, M., Schmidt, T., Bellosa, F.: Turbocc: a practical frequency-based covert channel with intel turbo boost. arXiv preprint arXiv:2007.07046 (2020)
17. Salh, A., et al.: Low computational complexity for optimizing energy efficiency in mm-wave hybrid precoding system for 5G. IEEE Access **10**, 4714–4727 (2021)
18. Feng, S., Lu, X., Niyato, D., Wu, Y., Shen, X., Wang, W.: System-level security solution for hybrid D2D communication in heterogeneous D2D-underlaid cellular network. IEEE Trans. Wirel. Commun. **23**(10), 15054–15069 (2024)
19. Chanayai, S., Apavatjrut, A.: Fountain codes and their applications: comparison and implementation for wireless applications. Wireless Pers. Commun. **121**(3), 1979–1994 (2021)
20. Yuan, M., Qiao, Y., Yusun, F., Tang, J.: Fountain codes for reliable and deterministic packet transmission in industrial cloud control systems. IEEE Internet Things J. **10**(8), 7114–7125 (2022)
21. Nie, H., Jiang, X., Tang, W., Zhang, S., Dou, W.: Data security over wireless transmission for enterprise multimedia security with fountain codes. Multimedia Tools Appl. **79**, 10781–10803 (2020)
22. Cui, M., Zhang, H., Huang, Y., Xu, Z., Zhao, Q.: A fountain-coding based cooperative jamming strategy for secure service migration in edge computing. Wireless Netw. **30**(5), 3643–3656 (2024)
23. Shanthi, G., Vishwakanth, Y., Dharma Teja, L., Ashok Kumar, P., Kumar, A.S.: Design of low-power turbo coder for low-energy mobile communications. In: 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), pp. 1–7. IEEE (2023)
24. Rowshan, M., Qiu, M., Xie, Y., Gu, X., Yuan, J.: Channel coding toward 6G: technical overview and outlook. IEEE Open J. Commun. Soc. **5**, 2585–2685 (2024)
25. Chaikalis, C., Kosmanos, D., Samaras, N.S.: Utilizing turbo codes for secure 5G V2X. In: 2020 IEEE Microwave Theory and Techniques in Wireless Communications (MTTW), vol. 1, pp. 30–34. IEEE (2020)

26. Kovtun, V., Ivanov, Y.: Crypto coding system based on the turbo codes with secret keys. ICT Express **10**(2), 330–335 (2024)
27. Shu, X.B., Li, L.N., Ren, M.M., Mohammed, B.O.: A new binary to gray code converter based on quantum-dot cellular automata nanotechnology. Photonic Netw. Commun. **41**(1), 102–108 (2021)
28. Basha, N., Hamdaoui, B., Al-Fuqaha, A.: Enhancing wireless secret-key generation through time-frequency analysis using wavelet coherence. In: In: GLOBECOM 2024–2024 IEEE Global Communications Conference, pp. 1125–1130. IEEE (2024)
29. Khan, S., Lansheng, H., Qian, Y., Lu, H., Meng Jiao, S.: Security of multimedia communication with game trick based fast, efficient, and robust color-/gray-scale image encryption algorithm. Trans. Emerg. Telecommun. Technol. **32**(2), e4034 (2021)
30. Alkhamese, A.Y., et al.: Secured gray-code-based steganographic technique in geometrical-based domain. IEEE Access **11**, 146161–146172 (2023)

Correction to: Comprehensive Evaluation of Anomaly Detection Methods for Time Series

Diksha, Kirti, Riya Verma, Aditi Gulati, Vivekanand Jha, and Deepika Suhag

Correction to:
Chapter 3 in: A. Swaroop et al. (Eds.): *Proceedings of Data Analytics and Management*, LNNS 1608, https://doi.org/10.1007/978-3-032-03740-4_3

The original version of the chapter was inadvertently published with the unintended phrase. The title of the chapter has been updated as "**Comprehensive Evaluation of Anomaly Detection Methods for Time Series**".

The updated version of this chapter can be found at
https://doi.org/10.1007/978-3-032-03740-4_3

A. Swaroop et al. (Eds.): ICDAM 2025, LNNS 1608, p. C1, 2026.
https://doi.org/10.1007/978-3-032-03740-4_47

Author Index

A. Swaroop et al. (Eds.): ICDAM 2025, LNNS 1608, pp. 573–574, 2026.
https://doi.org/10.1007/978-3-032-03740-4