AI-BASED POLLUTANT TRANSPORT MODELLING IN FRESHWATER ECOSYSTEMS USING: A CASE STUDY OF MALAPRABHA SUB-BASIN.

Project Reference No.: *49S_BE_5029*

College : SDM College of Engineering and Technology, Dharwad
Branch : Department of Civil Engineering
Guide(s) : Dr. Shruti Kambalimath
Student(s) : Ms. Zoya Adhoni
Mr. Siddharudhaswami Dollin
Ms. Anwita Kalginkar
Mr. Tejas Shet

Keywords:

Pollutant Transport, Transport Modelling, Spatial and Temporal Variation, Freshwater Ecosystems, Nutrient Pollution, Water Quality Modelling, Hydrological Modelling

Introduction:

1. Freshwater ecosystems like the Malaprabha River in Karnataka are vital for supporting regional water supplies, irrigation, and biodiversity. However, increasing pressures from agricultural runoff, untreated domestic wastewater, and industrial discharges have significantly disrupted the natural flow and chemical balance of these systems. Understanding how these pollutants are transported and dispersed through hydrological processes—such as flow and sediment interaction—is essential for managing water quality effectively.
2. This study evaluates the spatial and temporal variations of water quality across several stations, including Khanapur, Badami, and Aihole. By analyzing key parameters like Dissolved Oxygen, pH, and nitrates, and utilizing advanced tools like Python and Random Forest Regression, the research aims to model contaminant fate. Ultimately, this work establishes a theoretical and analytical foundation to support the sustainable management and protection of vital freshwater resources.

Objectives:

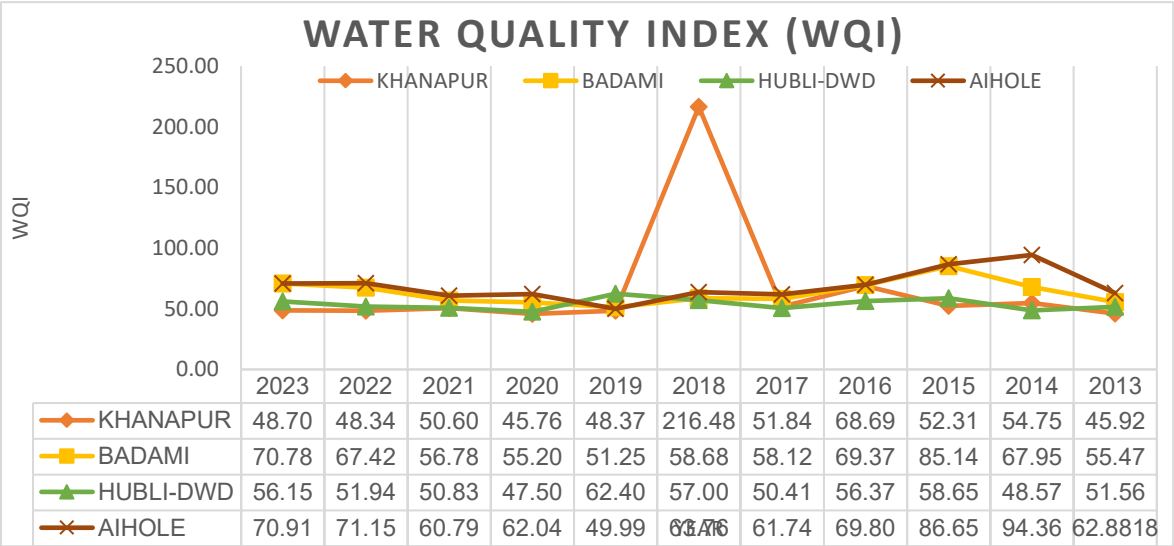
1. To analyze the physical, chemical, and biological parameters influencing pollutant transport and dispersion in lakes and streams.
2. To assess the spatial and temporal variation of pollutant concentration under different hydrological and seasonal conditions.
3. To identify key sources and pathways of pollutants entering freshwater ecosystems.
4. To model pollutant transport and dispersion dynamics using suitable analytical or numerical approaches.
5. To evaluate the impact of pollutant transport on water quality, aquatic life, and overall ecosystem health.

Methodology:

To achieve the above objectives the following methodology is considered

1. Data Collection.
2. Study Area Delineation and Marking of Sampling Points.
3. Calculation of Water Quality Index (WQI) Manually by formula.
4. Pollution Transmission Modelling by using Python Programming.
5. Prediction Water Quality Index by Random Forest Regression.
6. Result and Discussion.
7. Conclusion.

Result And Conclusion:



	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
KHANAPUR	48.70	48.34	50.60	45.76	48.37	216.48	51.84	68.69	52.31	54.75	45.92
BADAMI	70.78	67.42	56.78	55.20	51.25	58.68	58.12	69.37	85.14	67.95	55.47
HUBLI-DWD	56.15	51.94	50.83	47.50	62.40	57.00	50.41	56.37	58.65	48.57	51.56
AIHOLE	70.91	71.15	60.79	62.04	49.99	63.76	61.74	69.80	86.65	94.36	62.8818

			WATER	QUALITY	INDEX (WQI)			
YEAR	KHANAPUR	CLASS	BADAMI	CLASS	HUBLI-DWD	CLASS	AIHOLE	CLASS
2023	48.70	Excellent	70.78	GOOD	56.15	Good	70.91	Good
2022	48.34	Excellent	67.42	GOOD	51.94	Good	71.15	Good
2021	50.60	Good	56.78	GOOD	50.83	Good	60.79	Good
2020	45.76	Excellent	55.20	GOOD	47.50	Excellent	62.04	Good
2019	48.37	Excellent	51.25	GOOD	62.40	Good	49.99	Excellent
2018	216.48	Very poor	58.68	GOOD	57.00	Good	63.76	Good
2017	51.84	Good	58.12	GOOD	50.41	Good	61.74	Good
2016	68.69	Good	69.37	GOOD	56.37	Good	69.80	Good
2015	52.31	Good	85.14	GOOD	58.65	Good	86.65	Good
2014	54.75	Good	67.95	GOOD	48.57	Excellent	94.36	Good
2013	45.92	Excellent	55.47	GOOD	51.56	Good	62.88176	Good

Figure 1: RESULTS OF WATER QUALITY INDEX(WQI)

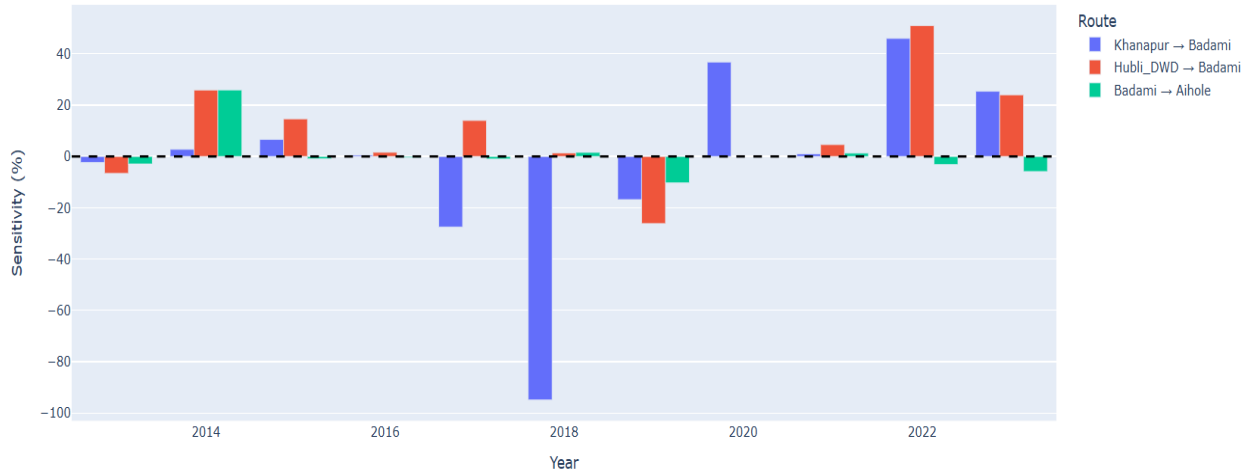


Figure 2: UPSTREAM-DOWNSTREAM SENSITIVITY OF WATER QUALITY

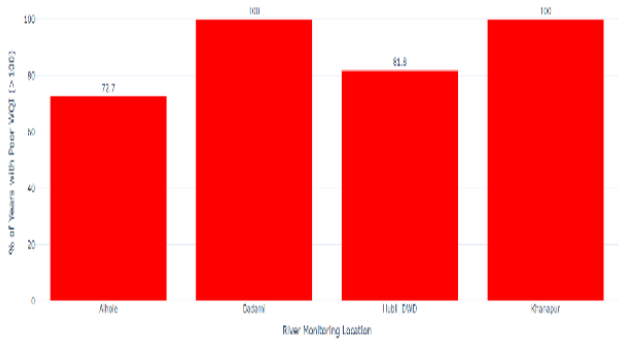


FIGURE 3: PERSISTENT POLLUTION HOTSPOT DETECTION

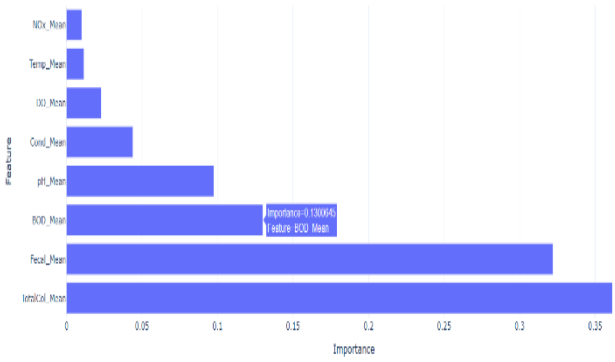


Figure 4: FEATURE IMPORTANCE DRIVING WATER QUALITY INDEX

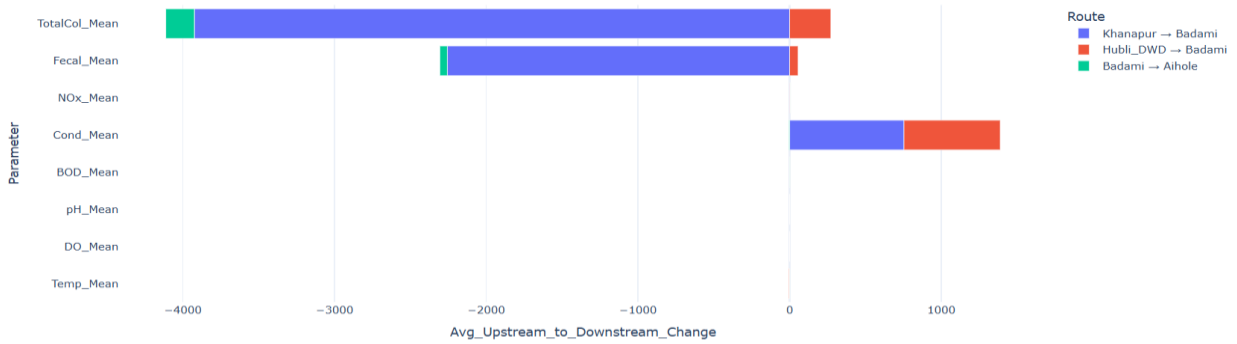


Figure 5: DOMINANT PARAMETERS DRIVING DOWNSTREAM DEGRADATION

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Future Scope:

- Predicting Future Quality: Use advanced AI tools like LSTM (Long Short-Term Memory) to predict future water conditions based on past trends.
- Real-Time Tracking: Set up IoT (Internet of Things) sensors in the river to get instant, live updates on pollution levels.
- New Pollutants: Expand the study to look at a wider variety of chemical and biological pollutants.
- Better Flow Models: Improve calculations on how pollutants spread (dispersion) to create more accurate river maps.
- Policy Support: Provide data to help local authorities create better rules for protecting the Malaprabha River.
- Siltation Impact: Research how the buildup of sediment (silt) at the bottom of the river affects water quality over time.