Investigation of Water Quality Characteristics of River Ganga at Different Ghats in Varanasi

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Abstract- ***The objective of this essay is to assess the character of the water in Varanasi's Ganga River. The present investigation illustrates the seasonal fluctuations in the concentration of physicochemical factors in the Ganga at the various ghats of Varanasi city. During the winter and rainy months of 2024–2025, water samples were collected from a variety of locations in Varanasi, such as the Santravidas Ghats, Assi Ghats, Harish Chandra Ghats, Dasawamedha Ghats, Lalita Ghats, Mannmandir Ghats, and Namo Ghats. Physicochemical parameters, such as pH, temperature, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity (TA), total hardness (TH), total dissolved solids (T.D.S), turbidity, and chloride, were employed to assess the pollution of the Ganga at discrete locations. The estimated values, when compared to the World Health Organization's and standard quality management standards, suggest that the water in the research area is contaminated, which could pose a threat to the aquatic ecology and human health.***

I. INTRODUCTION

A. Ganga River

In addition to being the most revered river in Hinduism, the Ganga provides millions of Indians who reside along its banks with day-to-day necessities. The Ganga is a transboundary river that serves as a conduit between India and Bengal. The Ganga is the longest watercourse in India. These 2,525 kilometer rivers originate in the western Himalayas and flow into the Bay of Bengal in the Gangatic plain of north India to the south and east. With a population density of approximately 1,000 and a population exceeding 400 million, 390 persons per square mile (390/km2) is the population density of the Ganges basin, which is the most densely populated river basin in the globe. The Ganga was designated as one of the five most polluted rivers in the globe in 2007. One example is the Ganga Action Plan. The Ganga Action Plan, an environmental initiative seeking to clean up the river, has failed woefully as a result of inadequate environmental planning, Indian customs and beliefs, and a lack of support from religious leaders. (Ali1 et al., 2017)

B. Ganga River Qualities

Hinduism's mythology asserts that the Ganga River offers numerous therapeutic advantages. The Ganga River is an excellent location for biodiversity. There are five area hook support birds that are unique to this region, as well as 90 amphibian species and over 140 fish species. The Ganga River generates the most fertile soil on Earth. According to environmental engineers at IIT Roorkee, the Ganga decomposes organic waste at a rate that is 15–25 times faster than that of other rivers. The Ganga River is distinguished by its therapeutic properties in comparison to other Himalayan rivers (Tiwari et al., 2022). According to the National Botanical Research Institute (NBRI), Ganga water possesses antibacterial properties.

C. Varanasi City's Ganga River

Varanasi's Ghats are the riverbank steps that lead to the margins of the Ganges River. The city is home to 88 ghats. Some of the ghats are exclusively used for cremation, while the majority are used for puja ceremonies and cleansing. The preponderance of Varanasi Ghats were constructed after 1700 AD, when the city was a part of the Maratha Empire. (2010, Namrata) Marathas, Peshwes (Peshwas), Holkars, Shindes (Scindias), and Bhonsles are the current supporters of the Ghats. Although numerous Ghats are privately owned, a significant number are associated with myths or folklore. The Ganges boat journey across the Ghats in the morning is a popular tourist attraction.

II. GOAL OF THE WORK

Analysis of the Ganga's physico-chemical characteristics at various Ghats in Varanasi city.

Study the changing nature of water's physical and chemical characteristics throughout time.

III. METHODOLOGY

The initial step in the physico-chemical parameter analysis procedure was sample collection. The sampling was conducted during the frigid and rainy seasons of 2024–2025. The following must be mentioned at the very least before a sample program is initiated: a comprehensive sampling procedure must be established. (Ali1) et al., 2017b

1) The sampling strategy
2) Labeling of samples
3) Storage of samples
4) Sample Testing

Samples will be collected from the numerous Ghats, the locations of which are listed below. The sample is extracted from the sealed container and stored in the refrigerator of the environmental engineering laboratory. Singh et al. (2018)

The water sample is analyzed for physic-chemical parameters, including pH, temperature, Alkalinity, turbidity, chloride, BOD, COD, DO, TDS, TSS, and total hardness, within 24 hours of collection. (Troubadour et al., 2020) As follows are the various water location parameters for the sampling sites in this experiment.

IV. AREA OF STUDY

Consequently, the present investigation evaluates the influence of the Ganga River's water quality on Varanasi. Eleven critical physiochemical parameters are estimated in accordance with a predetermined protocol. The water sample was collected from the nine most frequently visited ghats in Varanasi city (from Ravi Dash ghat to Namo ghat) during the research period, which corresponds to the winter and summer seasons of 2025 (Rai et al., n.d.). The physicochemical parameters are analyzed in the laboratory.

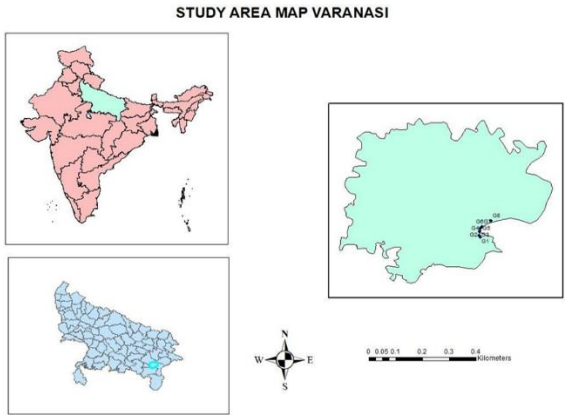

Figure 1 Study Area Ma

SELECTED PARAMETER FOR TESTING OF RIVER GANGA WATER.

1. PH
2. Temperature
3. Total Dissolved Solid
4. Total Suspended Solid
5. Dissolved Oxygen
6. Biological Oxygen Demand
7. Chemical Oxygen Demand
8. Hardness
9. Alkalinity
10. Turbidity
11. Chloride

A SAMPLE OF WATER WAS GATHERED FROM THE FOLLOWING LOCATION.

Samples 1 and 2 were collected at Ravi Dash Ghat, Assi Ghat, and Harishchanra Ghat, respectively.

Four samples were collected from Lalita Ghat, five from Dashashwamedh Ghat, six from Maan Mandir Ghat, seven from Manikarnika Ghat, and eight from Namo Ghat.

THE POLLUTANT SOURCE

There are two types of pollution.

1) Origination point
2) A source that is not a point source

1) Origination point

A singular, identifiable source of pollution, such as a pipe or drain, is referred to as a point source. This is

the conventional approach to the disposal of industrial refuse in the ocean and rivers.

1) Sewage effluent discharge
2) Domestic waste
3) Industrial waste products
4) The textile industry
2) A source that is not a point source

Non-point sources of pollution, which are frequently referred to as "diffuse" pollution, are those inputs and effects that are difficult to identify as a single source and are dispersed over a large area. In contrast to discrete point source releases, they are frequently associated with particular land uses. (Dutta et al., 2020)

1. Solid waste
2. Ghats for cleansing and bathing 3. Runoff from agricultural fields
4. Fecal matter containing excrement from both humans and animals
5. Cremation

V. BIS 10500, Drinking Water Standard, 2012

PARAMETER	DESIRABLE LIMITS	MAX.PERMISSIBLE LIMIT
PH –VALUE	6.5	8.5
DO	2 mg\l	6 mg/l
BOD		6 mg
ALKALINITY	200 mg/l	600 mg/l
TURBIDITY	1 NTU	5 NTU
CALCIUM	75 mg\l	200 mg/l
FLUORIDE	1 mg/l	1.5 mg/l
TDS	500 mg/l	2000 mg/l
CHLORIDE	250 mg/l	1000 m/l

S.NO	SAMPLING SITE LOCATION	PH	TEMP (^{0}C)	TDS (mg/l)	TSS (mg/l)	DO mg/l	BOD (mg/l)	COD(mg/l)	HARDNEES (mg/l)	ALKALINITY (mg/l)	TURBIDITY (mg/l)	CHLORIDE (mg/l0
1	RAVI DASH GHAT	7.3	29.2	52	225	5.32	5.21	6.43	245	182	11.32	135
2	ASSI GHAT	7.4	29.2	45	268	4.53	4.56	6.98	253	174	11.94	129
3	HARISHCHANR A GHAT	7.2	30.4	67	283	4.54	5.86	7.84	268	194	13.45	141
4	LALITA GHAT	7.9	30.8	42	268	5.46	3.89	6.76	273	175	12.24	142
5	DASHASHWAM ED GHAT	7.4	31.2	56	240	5.96	4.65	7.11	251	178	12.84	136
6	MAAN MANDIR GHAT	7.5	31.6	46	245	6.54	3.76	6.56	261	169	11.54	134
7	MANIKARNIKA GHAT	7.1	31.9	58	264	7.43	3.43	5.43	254	155	11.10	130
8	NAMO GHAT	7.2	29.2	48	220	5.31	5.22	6.42	243	181	11.22	127

Table 1: The physico-chemical data table of the Ganga in Varanasi (during the rainy season)

S.NO	SAMPLING SITE LOCATION	PH	TEM P (^{0}C)	TDS (mg/l)	TSS (mg/l)	DO (mg/l0	BOD (mg/l)	COD (mg/l)	HARDNESS (mg/l)	ALKALINITY (mg/l)	TURBIDITY (mg/l)	CHLORIDE (mg/l)
1	RAVI DASH GHAT	7.9	11.4	48	218	5.98	4.21	5.56	265	145	9.54	121
2	ASSI GHAT	8.6	11.5	41	245	5.76	4.12	5.38	260	138	9.24	118
	HARISHCHANR A GNAT	8.7	11.6	62	264	4.96	4.96	6.10	276	131	10.22	124

4	LALITA GHAT	8.6	14.1	38	248	5.65	3.23	5.19	279	128	9.54	130
5	DASHASHWAM EDH GHAT	8.5	12.4	53	229	6.06	3.54	5.98	266	146	9.29	120
6	MAANMANDIR GHAT	8.8	15.2	41	238	6.54	3.54	5.64	268	136	9.08	116
7	MANIKARNIKA GHAT	8.9	16.2	52	238	7.21	3.21	4.21	261	130	8.94	114
8	NAMO GHAT	7.6	10.8	49	217	5.91	4.25	5.57	270	140	9.58	123

Table 2: Varanasi's Ganga physico-chemical data table (during the winter season)

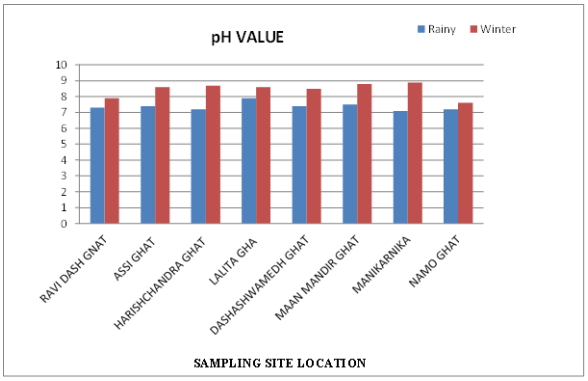

Fig. 2: A graph displaying the pH values at several sampling sites

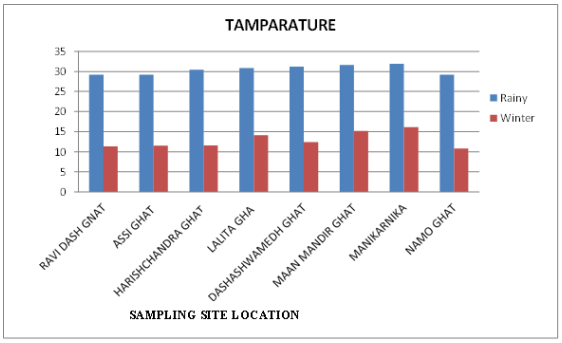

Fig. 3: A graph displaying the temperature values at several samples sit

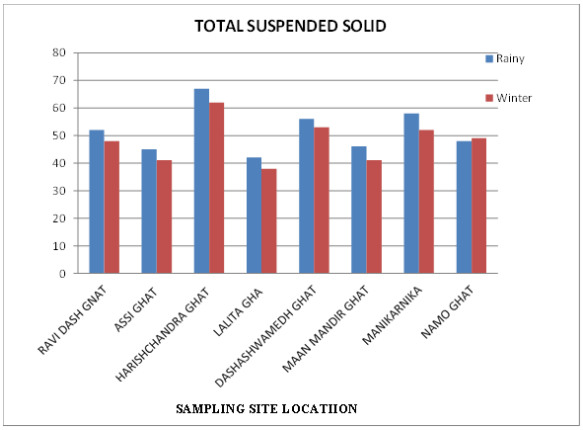

Fig. 4: A graph displaying the total suspended solids value at various samples

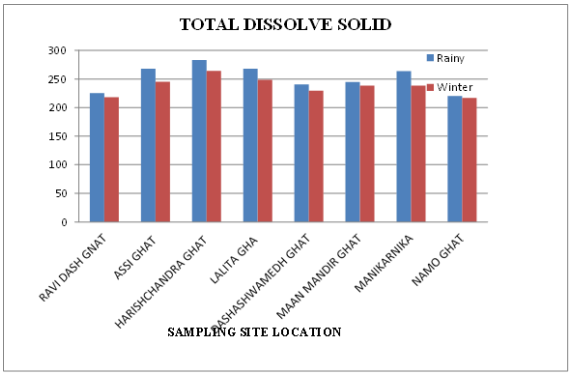

Fig. 5: A graph displaying the total dissolves solid value at several sampling sites

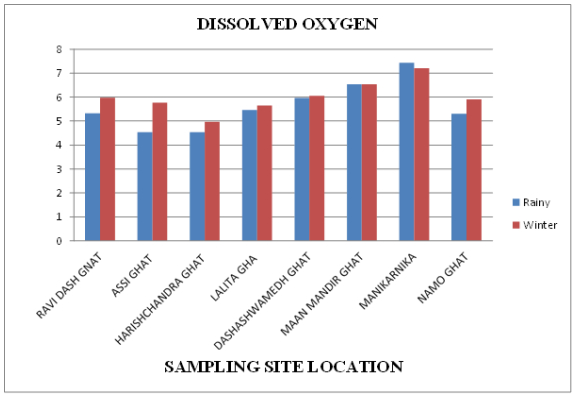

Fig. 6: A graph displaying the dissolved oxygen value at various sampling sites

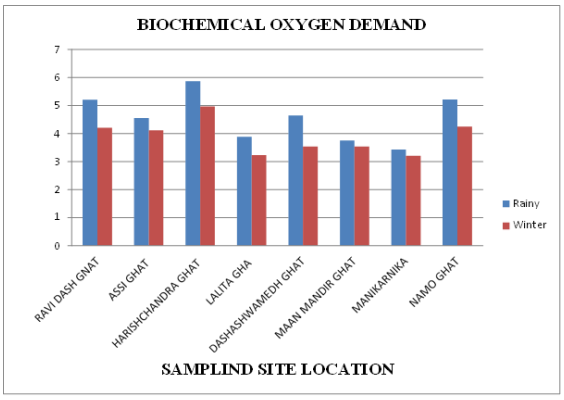

Fig.7: A graph displaying the B.O.D. value at several sampling sites

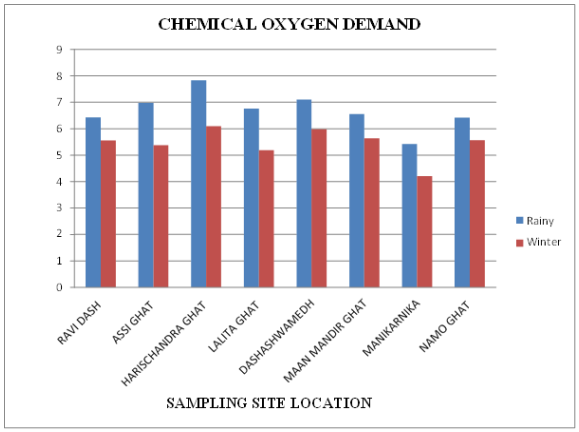

Fig. 8: A graph displaying the C.O.D. value at several sampling sites

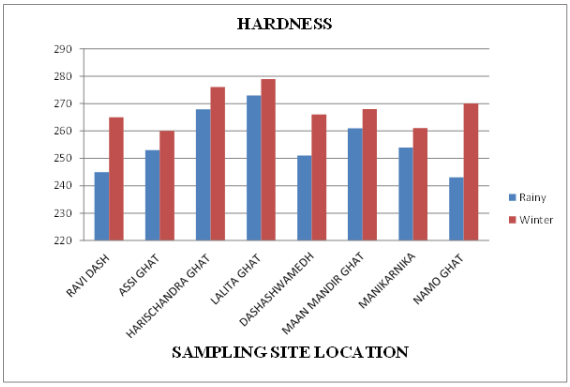

Fig. 9: A graph displaying the hardness value at several sampling sites

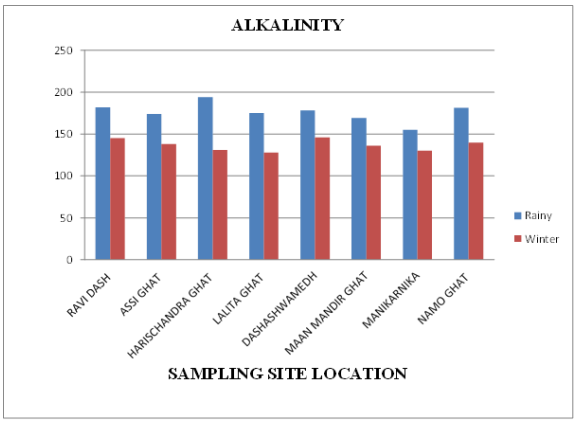

Fig. 10: A graph displaying the alkalinity value at various sampling sites

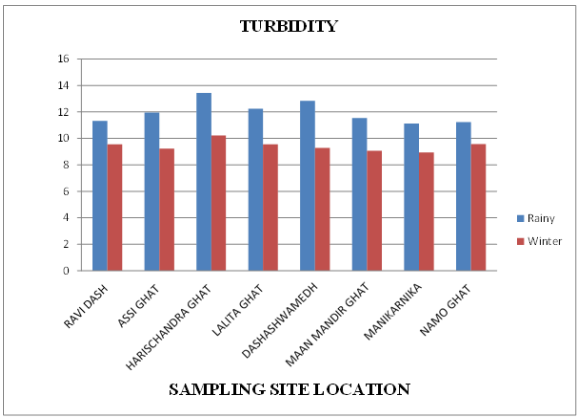

Fig. 11: A graph displaying the turbidity values at several sampling sites

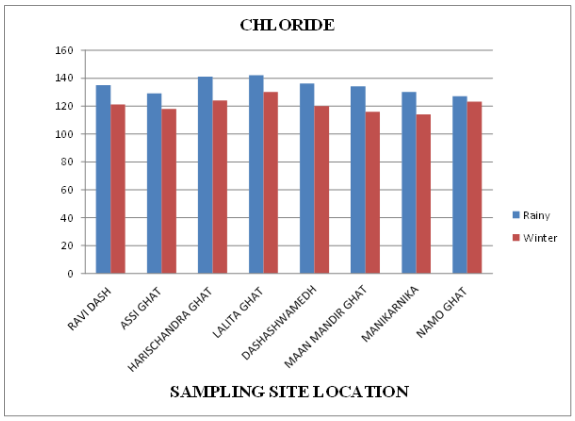

Fig. 12: Chloride values at various sampling sites are displayed in a graph.

VI. RESULTS AND CONCLUSION

A. ph.-value.

The maximum pH value is 7.9 at Ghat Lalita and the lowest is 7.1 at Manikarnika Ghat during the rainy season; during the winter, the highest pH value is 8.9 at Manikarnika Ghat and the lowest is 7.6 at Namo Ghat. When analyzed site-by-site, Dasawamedh Ghat had the lowest score (7.6) and Lalita Ghat had the highest value (8.5)(Singh et al., 2018)

B. Temparature

Mankarnika Ghat has the maximum temperature (31.9°C) and the lowest temperature (29.2°C) during the rainy season, whereas Mankarnika Ghat has the highest temperature (15.4°C) and Namo Ghat has the lowest temperature (10.8°C) during the winter.

C. Total Dissolved Solid. (TDS)

During the season of rain, Harischandra Ghat had the greatest Value of TDS (283 mg/l) and Namo ghat had the lowest amount (220 mg/l); during the winter, Manikarnika Ghat had 264 mg/l, the maximum TDS value and Ravi Dash ghat had the lowest TDS (218 mg/l). When analyzed per location, Harischandra Ghat had the highest result (283 mg/l), whereas Ravi Dash Ghat had the lowest value (218 mg/l).

D. Total Suspended Solid. (TSS)

During the rainy season, the lowest TSS value was 42 mg/l at Lalita Ghat and the highest was 67 mg/l at Harischandra Ghat. On the other hand, during the winter, the TSS value at Lalita Ghat was 38 mg/l and the highest was 62 mg/l at Harischandra Ghat. Site-by-site analysis revealed that Lalita Ghat had the lowest concentration (38 mg/l) and Harischandra Ghat had the highest (67 mg/l).

E. Oxygen Dissolved (DO)

Manikarnika Ghat has the highest DO value (7.43 mg/l) and Assi Ghat has the lowest value (4.53 mg/l) during the rainy season; Harish Chandra Ghat has the lowest DO (4.96); and Manikarnika Ghat has the highest DO value (7.21 mg/l) during the winter. Site-by-site analysis revealed that Harishchandra Ghat had the lowest value (4.96 mg/l) and Manikarnika Ghat had the highest value (7.43 mg/l).

F. Biochemical Oxygen Demand (BOD)

The maximum BOD levels are 4.96 mg/l at Harischand Ghat and 3.21 mg/l at Mankarinka Ghat during the winter and 5.86 mg/l at Harischand Ghat and 3.43 mg/l at Mankarinka Ghat during the rainy season. Mankarinka Ghat had the lowest result (3.21 mg/l) and Harischand Ghat had the highest value (5.86 mg/l) when examined by site.

G. Chemical Oxygen Demand.

Harischand Ghat and Mankarinka Ghat have the highest COD levels during the rainy season (7.84 mg/l and 5.43 mg/l, respectively); in the winter, Harischand Ghat has the highest COD levels (6.10 mg/l and 4.21 mg/l, respectively). Mankarinka Ghat had the lowest result (4.21 mg/l) and Harischand Ghat had the highest value (7.84 mg/l) when examined by site.

H. Hardness.

During the season of rain, Lalita Ghat has 273 mg/l is the maximum hardness value and Ravi dash Ghat has the lowest concentration (245 mg/l); during the winter, Lalita Ghat has greatest value of hardness (279 mg/l) and ASSI Ghat has the lowest hardness (260 mg/l).

When evaluated per site, Assi Ghat had the lowest result (260 mg/l) while Lalita Ghat had the highest (273 mg/l).

I. Alkalinity.

The maximum alkalinity values during the rainy season are 194 mg/l at Harish Chandra Ghat as well as At Manikarnika Ghat, 155 mg/l; during the winter.The maximum alkalinity values are Dasawamadh Ghat has 146 mg/l and 128 mg/l at Lalita Ghat. When analyzed by site, Harishchandra Ghat had the maximum amount (194 mg/l) while Lalita Ghat had the lowest concentration (128 mg/l).

J. Turbidity.

The maximum turbidity values during the rainy season are 13.45 NTU at Harishchandra Ghat and 11.10 Manikarnika Ghat NTU; during the peak turbidity occurs in winter. Values are 8.94 NTU at Harishchandra Ghat and 4.96 NTU at Manikarnika Ghat. When analyzed by location, Manikarnika Ghat had the lowest value of 4.96 NTU while Harishchandra Ghat had the highest value of 13.45 NTU.

K. Chloride.

Lalita Ghat has the highest concentration of chloride (142 mg/l) and Assi Ghat has the lowest (129 mg/l) during the rainy season; in the winter, Lalita Ghat has the highest concentration (130 mg/l) and Manikarnika Ghat has the lowest (114 mg/l). Lalita Ghat had the highest result (142 mg/l) and Ghat Manikarnika had the lowest amount (114 mg/l) when examined by site.

CONCLUSION

Therefore, we can conclude that the discharge of untreated sewage and industrial effluents, along with the washing in of pesticide and insecticide residues from both point and non-point sources, causes the Ganga River to become seriously contaminated. According to my assessment of the physico-chemical characteristics of the Ganga, I am of the opinion that the water is unsuitable for residential use and necessitates further treatment. The establishment of numerous hospitals, industries, textile mills, chemical facilities, and distilleries on Varanasi's Ganga bank has resulted in an increase in the Ganga's pollution level. Water samples from several Ghats were analyzed, and it was discovered that the river and river body were more Contaminated at Harishchandra Ghats because of the high volume of industrial waste, sewage discharge, and cremation operations. (Jazie, n.d.)

RECOMMENDATION

There are the following suggestions for the Ganga's enhancement:

1) In order to mitigate the environmental hazards resulting from these factors and improve the environmental protection of this region, it is necessary to implement rigorous law enforcement and routine monitoring. Our current data should serve as a baseline for future reference.

2) The majority of municipal and industrial waste is disposed of in rivers without regard for the potential impact on human health or aquatic life. Consequently, it is unlawful to directly discharge of sewage waste in rivers.

3) Implement legislation to penalize those who pollute the Ganga and to increase water supplies to improve the river's quality.

4) Sewage treatment facilities are stabilized in close proximity to the Ganga River to protect the direct discharge of sewage waste. It is crucial to divert all effluent from drains that enter the river.

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