Indra Gandhi Cannal and Ground Water Quality of Surrounding Areas

Dr. Chetan Kumar Joshi, Bhawani Shankar, Savita Kumari, Dr. Sumit, Dr. Avadhesh Sharma Anil

Abstract: *The increasing spread of salinity and water logging in the Indira Gandhi Nahar Pariyojana (IGNP) command area has become a major environmental and agricultural concern. High temperatures in the region, combined with large amounts of salts soluble in water that exist in the soil and intense evaporation and transpiration, have accelerated the process of secondary salinization. As a result, salts are gradually accumulating both on surface of soil and within deeper soil stratum. In addition, the presence of an impenetrable subsurface layer and the absence of adequate drainage systems for removing excess surface water have led to a continuous rise in the groundwater table, which ultimately causes waterlogging. These conditions threaten the sustainability of irrigated agriculture in the IGNP region, as increasing soil salinity adversely affects crop productivity. With time, large areas of land have become unsuitable for farming.*

The quality of water is largely affected by the nature and chemical composition of the underlying bedrock, particularly in the case of groundwater. Therefore, evaluating water quality requires a careful analysis of both its physical and chemical parameters. Physical characteristics of water include properties such as turbidity, taste, odour, colour, temperature, total dissolved solids, and electrical conductivity. On the other hand, chemical characteristics are determined by parameters such as hydrogen ion concentration (pH), acidity, alkalinity, chlorides, residual chlorine, sulphates, nitrogen compounds, fluorides, and trace metals like copper, iron, zinc, and manganese. In addition, indicators such as dissolved oxygen (DO) and biochemical oxygen demand (BOD) are also measured to assess the chemical condition and overall health of the water.

Dr. Chetan Kumar Joshi (cjoshisk@gmail.com)Associate Professor, Department of Zoology, Government Science College,Sikar, Rajasthan
Bhawani Shankar (bspareek0021@gmail.com) Research Scholar,Department of Zoology, Government Science College, PDUSU Sikar, Rajasthan
Savita Kumari (Choudharysavita974@gmail.com) Research Scholar,Department of Zoology, Government Science College, PDUSU Sikar, Rajasthan
Dr. Sumit (sssranwa@gmail.com) Assistant Professor, Department Of Chemistry, Government Science College,Sikar, Rajasthan
Dr. Avadhesh Sharma Anil (Dr.avadhesh81@gmail.com)Assistant Professor, Department Of Zoology, S. N. K. P. Government College, Neemkathana, Sikar, Rajasthan

ISSN: 0262-8104 (print) 1756-3488 (online)
Waterlines Vol. 44 No. 3s

Keywords: *The Indira Gandhi Canal Project (IGNP), geology, water salinity, physico- chemical characteristics.*

Introduction

The Indira Gandhi Canal Project **(IGNP)** is among the most significant irrigation projects of India and serves a pivotal part in transforming the arid regions of north-western Rajasthan into productive agricultural land. The project was designed to utilize the waters of the Sutlej River and Beas River, which are diverted through the Harike Barrage in the state of Punjab. From this point, the canal carries water across the Thar Desert region of Rajasthan, supplying irrigation and drinking water to several drought-prone districts.

The project was originally known as the Rajasthan Canal Project, and it was later renamed in honor of Indira Gandhi. Construction of the canal began in the 1950s, and the system was developed in two major phases to extend irrigation facilities across a vast desert area. The canal network mainly benefits districts such as Sri Ganganagar, Hanumangarh, Bikaner, Jaisalmer, and Barmer, where water scarcity has historically limited agricultural and socio-economic development.

The region surrounding the Indira Gandhi Canal Project lies in the north-western part of Rajasthan, mainly within the Thar Desert. The geology of this area is largely dominated by Quaternary and Tertiary deposits consisting of sand, silt, clay, and calcareous materials. Much of the surface is covered with wind-blown (aeolian) sand that has accumulated over long periods due to desert climatic conditions. Beneath these sandy layers, older sedimentary formations and alluvial deposits are found, which influence groundwater occurrence and soil characteristics in the region. In some places, gypsum and other soluble salts are also present, contributing to the saline nature of soils and groundwater.

The landforms of the IGNP command area are mainly shaped by wind action and arid climatic processes. The terrain is generally flat to gently undulating and is characterized by sand dunes, interdunal plains, sandy plains, and occasional saline depressions known as playas or “dhands.” Longitudinal and parabolic dunes are common features, especially in districts such as Bikaner and Jaisalmer. Interdunal areas often contain finer sediments and are relatively more suitable for agriculture after irrigation.

With the introduction of canal irrigation through the Indira Gandhi Canal Project, the natural landscape has undergone noticeable changes. Stabilization of sand dunes, development of agricultural fields, and increased vegetation cover have modified the original desert landforms. However, the region still reflects the typical geomorphological characteristics of an arid desert environment shaped by wind, sparse rainfall, and sandy geological formations (CGWB).

Study Area

IGNP Level–I:
Level–I represents the upper section of the Indira Gandhi Canal Project. This stage encompasses a 204 km long supply channel that originates from the Harike Barrage in Punjab. From the Masitawali head, the main canal extends for about 189 km up to the Pugal head. In addition, this stage is supported by a distribution system of nearly 3,400 km. For effective management and development, Stage–I is split into 2 phases.

- Phase I: This phase envelops the area receiving water from the beginning of the canal up to the 74 km mark of the principal waterway.
- Phase II: This phase encompasses the regions irrigated by the canal branches that extend between 74 km to 189 km along the main waterway.

The total culturable command area (CCA) of Level–I is approximately 5.53 lakh hectares. Out of this, about 61 thousand hectares belong to the Kanwar Sain Lift Canal- a part of Phase II. This lift canal mainly provides irrigation as well as drinking water to parts of the district Bikaner. The intensity of irrigation planned for this stage is about 110%. Important distribution channels within Level–I include the Naurangdesar, Rawatsar, Anupgarh, Pugal, and Suratgarh waterways.

IGNP Level–II:
Stage–II constitutes the lower portion of the canal system. It includes a 256 km long main canal that begins at the end point of Level–I near Pugal (189 km) and continues up to its terminal point near Mohangarh. This stage has a large distribution network of around 5,780 km, covering a culturable command area of approximately 14.10 lakh hectares.

In Level–II, the irrigation intensity has been designed at 80 percent for gravity irrigation system and 60 percent for lift irrigation system. Lift irrigation region itself covers nearly 5.37 lakh hectares of the total command area. The principal branch channels and distributaries in this level envelops Birsalpur, Dattor, Charanwala,

Sagarmal Gopa, Gadra Road, and Nachna. Development activities are still progressing in the areas located beyond the Sagarmal Gopa branch canal (CAD, IGNP).

Sardarshahar is situated in the heart of the Thar Desert, in Churu district (Rajasthan). Sardarshahar was founded in 1838 on the site of the village of Alwana in the former Bikaner State. The town derives its name from Sardar Singh, the son of the Bikaner ruler, Maharaja Ratan Singh.

At present, the primary source of water supply for Sardarshahar is the Indira Gandhi Canal. From this, the Sawashat Canal branches out, and its water is utilized to supply the existing 70 MLD capacity water treatment plant (WTP) located at Dhannasar (CGWB).

Materials and Methods

Water samples from dug wells and main canal will be collected in standard plastic bottles.
The samples will be collected from different sites such as Meharasar Sahajasar, Amarasar, etc villages situated at 50-60 km far from Sardarshahar town in North-East sides of the IGC area by using standard methods given in APHA guidelines. For further analysis, the samples were tested in laboratory. Analysis of Physico-chemical parameters such as conductivity, colour, odour, solids (dissolved), suspended solids, temperature, acidity, alkalinity, ammonical nitrogen, biochemical oxygen demand (BOD), calcium, chloride, chemical oxygen demand (COD), dissolved oxygen, fluoride, magnesium, hardness (calcium), hardness (total), pH, phosphate (total) and sulphate in the water sample were carried out.

Results

TABLE: 1

S.No.	PARAMETERS	YEAR 2024-25							
		Maharasar C	Maharasar2 C	Maharasar 1E	Sahajasar 1C	Sahajasar 1E	Sahajasar 2E	Amarasar 1E	IGC-W 1
1.	**Temperature**	19.5	19.7	**20.3**	19.1	**19.0**	**20.3**	**19.5**	**19.7**
2.	**Colour**	<1	<1	<1	<1	**<1**	**<1**	**<1**	**<1**

3.	**Odour**	Agree	Agree	Agree	Agree	**Agree**	**Agree**	**Agree**	**Agree**
4.	**Ph**	7.25	7.92	**8.3**	**7.16**	**7.4**	**8.1**	**8.82**	**7.6**
5.	**Dissolved O2**	**7.4**	**6.0**	**7.4**	**6.2**	**7.8**	**8.4**	**8.0**	**7.8**
6.	**TSS**	<2	<2	<2	<2	**<2**	**<2**	**<2**	**<2**
7.	**Chlorides**	**604.81**	**559.82**	**1899.41**	**1099.65**	**139.95**	**15.99**	**17.99**	**19.99**
8.	**Sulphates**	**76.09**	**224.7**	**211.8**	**194.1**	**90.76**	**35.32**	**31.04**	**32.34**
9.	**Total Hardness**	**1060**	**1460**	**270**	**1070**	**270**	**60**	**56**	**128**
10.	**Ca**	**212**	**240**	**40**	**192**	**52**	**12.8**	**8.0**	**36.8**
11.	**Mg**	**127.2**	**206.4**	**40.8**	**141.6**	**33.6**	**6.72**	**8.64**	**8.64**
12.	**Phosphorus**	**0.05**	**0.08**	**0.07**	**0.02**	**0.02**	**<0.01**	**0.54**	**0.84**
13.	**Fluorides**	**<0.1**	**0.1**	**1.0**	**<0.1**	**<0.1**	**<0.1**	**0.8**	**<0.1**
14.	**Ammonical Nitrogen**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
15.	**TDS**	**1460**	**4140**	**2000**	**2780**	**640**	**200**	**420**	**180**
16.	**Conductivity**	**2250**	**6270**	**3080**	**4300**	**1040**	**330**	**660**	**280**
17.	**Total Alkalinity**	**164.05**	**241.25**	**579**	**193**	**281.78**	**135.1**	**308.8**	**96.5**
18.	**Total Acidity**	**20**	**25**	**40**	**20**	**25**	**35**	**50**	**25**

As mentioned in the table (1) various parameters studied during the investigation period show varied results. Accordingly, the water temperature was maximum at Sahajasar 2E and Mahrasar 1E sites (20.3 ^{0}C) and minimum was at Sahajasar 1C. The parameters such as colour (<1), odor (agreeable), TSS (<2) and Ammonical Nitrogen (<0.1) showed no variation at all the seven sites. Amarasar 1E showed the highest value of pH 8.82 as compared to other sites. Dissolved Oxygen was maximum at Sahajasar 2E (8.4 mg/l) and minimum was recorded at Sahajasar 1C (6.2 mg/l). As per the results, Chemical Oxygen Demand (COD) was highest at Mehrasar –C with 232.92 mg/l whereas Biological Oxygen Demand (BOD) was highest at Mehrasar 2C with 108 mg/l. The Chlorides was maximum at Mehrasar 1E (1899.41mg/l) followed by Sahajasar 1C (1099.65mg/l) and minimum was recorded at Sahajasar 2E (15.99 mg/l). Mehrasar 2C (224.7 mg/l) recorded the highest Sulphate values followed by Mehrasar 1E (211.8 mg/l) and Sahajasar 1C (194.1 mg/l) whereas lowest values were recorded at Amarasar 1E (31.04 mg/l). Mehrasar 2C showed the maximum values of Total Hardness (1460 mg/l), Calcium ions (240 mg/l) and Magnesium ions (206.4 mg/l). Alkalinity was greatest at Mehrasar 1E (579

mg/l). Total Dissolved Solids and Electrical Conductivity were highest at Sahajasar 1C with 2780 mg/l and 4300 s/cm values respectively.

Discussion

As mentioned above the ground water of seven different sites were analyzed and the water from the IGNP was also tested for reference.

1. pH – The pH of a water system serves a pivotal part in controlling all chemical and biological processes (A. Sreenivason, 1967). Low pH levels can lead to corrosion and tuberculation, whereas high pH levels may result in scaling, deposition of sediments, and complications during chlorination for effective water disinfection (Prasad B. Guru, 2003).) Accordingly, the pH of sites Amarsar 1E, Sahajasar 2E, Mahrasar 1E and Mahrasar 2C were on an alkaline side as compared to other sampling sites especially the IGNP water. Similar findings were made by Mitharwal et al. (2009) on ground water of Pilani region, Rajasthan.
2. Dissolved Oxygen - It is one of the most important indicators of water quality because almost all aerobic aquatic organisms depend on it for survival. DO also influences and is influenced by numerous physical, chemical, and biological parameters in natural and engineered water systems. As per the Dissolved Oxygen values, the highest DO was exhibited by Sahajasar 2E (8.4 mg/l) followed by Amarasar 1E (8.0 mg/l). the lowest values were recorded at Mehrasar 2C (6.0 mg/l).
3. Electrical Conductance - Electrical conductance (or electrical conductivity, EC) is a key water quality parameter that stipulates the potential of water to transmit electricity. It is strongly correlated to the ionic strength such as salts, minerals, and inorganic compounds. The maximum Electrical Conductance was shown by the waters of Mehrasar 2C (6270µS/cm) site followed by Sahajasar 1C site (4300 µS/cm), then Mehrasar 1E (3080 µS/cm) and Mehrasar C (2250 µS/cm).
4. Total Dissolved Solids (TDS) – It pertain to the strength of all mineral salts and small amounts of detritus matter disintegrated in water. These include ions such as calcium, magnesium, sodium, potassium, bicarbonates, chlorides, sulfates, and nitrates. The highest allowable concentration of total dissolved solids (TDS) is 1500 mg/L, as recommended by ICMR and WHO (1984). The TDS was shown maximum by Mehrasar 2C with 4140 mg/l, followed by Sahajasar 1C with 2780 mg/l, Mehrasar 1E with 2000 mg/l, Mehrasar C with 1460 mg/l, Sahajasar 1E with 600 mg/l, Amarasar 1E with

420 mg/l, Sahajasar 2E with 200 mg/l and minimum was shown by IGCW 1 with 180 mg/l of TDS. Higher TDS increases water's ability to conduct electricity due to the presence of mobile ions.

5. Total Suspended Solids (TSS) - They are the solid substances present in water in dissolved form that can be trapped by a filter. These include silt, clay, sand, organic debris, plankton, and other particulate matter. All the eight sampling stations showed Total Suspended Solids less than 2 mg/l. TSS is a primary contributor to **turbidity**, making water appear cloudy or muddy.
6. Total Hardness - Water hardness is a key factor in assessing its suitability for domestic use, drinking purposes, and various industrial applications. Hard water may form precipitates of calcium or magnesium salts (e.g., $CaCO_3$), which can increase turbidity under certain conditions and Contribute to scaling and deposition in water bodies or pipelines. Total hardness ranged between 1460 mg/l to 56 mg/l. The recommended acceptable level for total hardness in water is 300 mg/L, as per ICMR guidelines.
7. Alkalinity - Alkalinity indicates the capacity of water to counteract acids, primarily due to the presence of bicarbonates (HCO_3^-), carbonates (CO_3^{2-}), and hydroxides (OH^-). In the present context alkalinity ranged between 96.5 mg/l to 579 mg/l.
8. Chlorides - Chloride contents in fresh water is largely influenced by evaporation and

   Precipitation **(**N. Kumarswamy,1991**).** Chloride is considered the most problematic anion in irrigation water. It is typically more harmful to plants than sulphate and serves as a reliable indicator of pollution (K. Vijayram et al. 1990 and H. Rai, 1979).
9. Sulphates - **Sulphates (SO_4^{2-})** are naturally occurring anions commonly found in surface water and groundwater. They originate from the weathering of sulphate-bearing minerals (such as gypsum and anhydrite), oxidation of sulphide minerals, atmospheric deposition, industrial effluents, and agricultural runoff. Sulphate was observed between 31.04 mg/l and 224.7 mg/l at Amarasar 1E and Mehrasar 2C respectively. Mehrasar 2C and Mehrasar 1E had sulphate content higher than desirable range of 200 mg/l (ICMR).
10. Phosphorus as Phosphate - phosphorus plays a critical role in controlling the physical condition, chemical behavior, and biological productivity of water bodies. Elevated phosphorus concentrations stimulate excessive algal and

phytoplankton growth. Here, phosphate content ranged between <0.01 mg/l to 0.84 mg/l. highest content was recorded at IGCW 1.

11. Ammonical Nitrogen - Ammonical nitrogen is an important indicator of water pollution and plays a significant role in influencing the physical appearance, chemical behavior, and biological health of aquatic systems. Ammonical Nitrogen was less than 0.1 mg/l at all the sampling stations.
12. Fluoride - **Fluoride (F^-)** is a naturally occurring anion present in surface water and groundwater, primarily originating from the weathering of fluoride-rich ores such as micas, apatite, and fluorite. Lower strength of fluorides is salutary for human dental health, excessive levels can cause serious health and ecological impacts. Fluoride was < 0.1 mg/l at most of the stations except for Mehrasar 1E (1.0 mg/l) and Amarasar 1E (0.8 mg/l).

Conclusion

On the basis of the above findings and their subsequent interpretation, it is clearly evident that the Indira Gandhi Nehar Pariyojna exerts a significant influence on the surrounding environment, particularly on local water sources and overall water quality. A comparative evaluation of key physio-chemical characteristics—such as Total Dissolved Solids (TDS), total hardness, alkalinity, chlorides, sulphates, and electrical conductance—reveals that the water samples collected from Sahajasar 2E and Amarasar 1E exhibit characteristics closely resembling those of IGCW 1 canal water.

In contrast, water samples from other monitoring stations display considerably higher values for these parameters, indicating variations in water quality across the region. This spatial disparity suggests that the canal system is actively interacting with the surrounding hydrogeological environment. The similarity in water quality between certain sampling locations and canal water strongly indicates the seepage or percolation of canal water into adjacent subsurface zones.

Such seepage contributes to the recharge of local aquifers, thereby altering the chemical composition of groundwater in nearby areas. Over time, this process can lead to significant changes in groundwater quality, which may have both beneficial and adverse implications depending on the extent and nature of the interaction. Therefore, the Indira Gandhi Canal not only serves as a crucial irrigation source but also plays a vital role in modifying the groundwater regime of the region.

References

Aquifer Mapping and ground water management plan Churu District, Rajasthan 2021-22. Central Ground Water Board, Ministry of Jal Shakti, Dept. of Water resources, River Development and Ganga Rejuvenation, Govt. of India.

CAD, IGNP (2009) Report of Command Area Development, Indira Gandhi Nahar Pariyojna, Bikaner.

Ground Water Book 2020-21. Central Ground Water Board, Ministry of Jal Shakti, Dept. of Water resources, River Development and Ganga Rejuvenation, Govt. of India.

APHA, 1989. Standard methods for the examination of water and waste water. American Public Health Association, Washington, D.C. (17th Ed.), 1452pp.

A. Sreenivason, F.A.O. Fish Rep, 44(3), 101 1967.

Prasad B. Guru, Evaluation of Water Quality in Tadepalli Mandal of Guntur Distt., A.P., Nature, Environ. and Poll. Techn., 2(3) 273-276 (2003).

S. Mitharwal, R.D. Yadav and R.C. Angasaria, 2009. Water quality analysis in Pilani of Jhunjhunu District (Rajasthan) – The place of Birla's Origin. Rasayan J. Chem. Vol. 2, No. 4, pp 920-923.

Manuals of Standards of Drinking Water Supply,ICMR, New Delhi, 2nd Special Report Series No. 44 (1975).

WHO, Guidelines for Drinking Water Quality, Recommendations WHO Geneva, 1, 1984b.

N. Kumarswamy, *Poll. Res.*, **10,** 13 (1991).

K. Vijayram, S.R. Vyasugi, S.Chitra, and U. Asha, *Poll. Res*., **9**, 133 (1990).

H. Rai, *Archiv Fish Hydrobiol*; **75**, 369 (1979).