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On

APPLICATION OF WATER QUALITY INDEX FOR GROUND WATER QUALITY ASSESSMENT IN MINING TALUKAS OF GOA

Presented

By

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INTRODUCTION

❖Groundwater comprises 97 percent of the world's readily accessible freshwater and provides the rural, urban, industrial and irrigation water supply needs of 2 billion people around the world.

❖In India almost 80% of the rural population depending on untreated ground water for potable water supplies (Reza et al., 2009).

❖Groundwater pollution has become a major subject of public concern the world over.

❖Mining is the major economic activity contributing about 20.4% of GSDP to the State's economy.

PHYSIOGRAPHY

- Goa lies - between N14° 53’ and N 15° 48’ and E 73° 39’ and E 74° 20’ respectively.
- Classified in to three types of terrain grading from:
  1. Low-lying coastal estuarine plains to the west
  2. Undulating region in the central part
  3. The steep slopes of the Western Ghats on the eastern border of the state.

STRUCTURAL FEATURES

- Goa group -folded and intruded by granite gneiss, felspathic gneiss, hornblende granite and porphyritic granite, followed by basic intrusives
- Exhibit evidences of three cycles of folding -resulted in green schist facies of metamorphic rocks
- Recent and sub-recent - rocks underwent laterisation resulting in Laterite cover of varying thickness.

IRON ORE RESERVES AND ITS CHARACTERISTICS

Location

1. North Goa Sector
2. Central Goa Sector
3. South Goa Sector

Structure

- The rocks trend -NWSE to NNW-SSE in central Goa and the trends towards EW in South Goa
- Litho units- highly folded and the rocks attained green schist facies grade of metamorphism

Mineralization

- Ore zones -cumulative strike length of 46 Km & width varying 10 m to 1Km
- Minerals of iron ore -Hematite, Magnetite and Limonite/ Goethite

Mode of occurrence

- Deposits confined to the pink phyllite horizon (Bicholim Formations)
- Occurs as blanket and lensoid bodies of varying dimensions

Distribution of Ore

- Iron ore deposits- localised in a general NW-SE direction over a length of 95Km from Naibagha in the northwest on the Goa-Maharashtra border, to Saliguinim in the South east near Goa-Karnataka border
- Distinct decrease in iron concentration and increase in manganese concentration
- Largest iron ore deposits - situated in north Goa

Hydrogeology

PARTICULARS	NORTH GOA	SOUTH GOA
1. Major Water Bearing Formations	Laterite, Alluvium, Granite, Granite Gneiss, Meta Volcanics & Meta Sedimentaries	
2. Pre - monsoon depth to water level during May 2011 (in m bgl)	2.17 to 19.23	2.39 to 18.64
3. Post – monsoon depth to water level during November 2011 (in m bgl)	0.43 to 14.90	1.20 to 14.52
Long term water level trend in 10 years (2001 – 2010) (in m/year)		
1. Pre - monsoon	Range from a Decline of 8.43m to Rise of 2.72m	Range from a Decline of 0.03m to rise of 2.07m
2. Post - monsoon	Range from a Decline of 1.62m to Rise of 4.13m	Range from a Decline of 0.06m to Rise of 8.24m

Goa: Water Table

•On an average from the Surface, water table is encountered at the depth ranging between 10m to 40m bgl (Below Ground Level) and 40m to 10m with respect to MSL.

Aquifer Systems Encountered In The Goa Region

Formation/ Aquifers	Yield (l/s)	Drawdown (m)	Sp. Capacity ($m^3/d/m$)	Transmissivity (m^2/day)
1. Granites & Gneisses	0.34- 8.8	17.68- 34.61	0.27- 43.00	0.2-30.6
2. Metabasalts	0.18- 9.9	1.9- 33.78	0.46- 141.20	0.2 - 232
3. Metasedimentaries	0.22 - 10	1.32- 34.40	0.47- 159.60	0.12 – 346
4. Alluvium	1.8- 2.5	0.87- 9.1	27 - 200	21 – 1776

Source: CGWB 2010

Dynamic Ground Water Resource (March 2009)

PARTICULARS	NORTH GOA	SOUTH GOA
(1) Net ground water availability (ham)	7,802	5,473
(2) Total Annual Ground Water Draft (ham)	2,547	1,837
(3) Projected demand for domestic & industrial uses upto 2025 (ham)	2,110	1,639
(4) Stage of Ground Water Development (%)	**33 % (SAFE)**	**34 % (SAFE)**

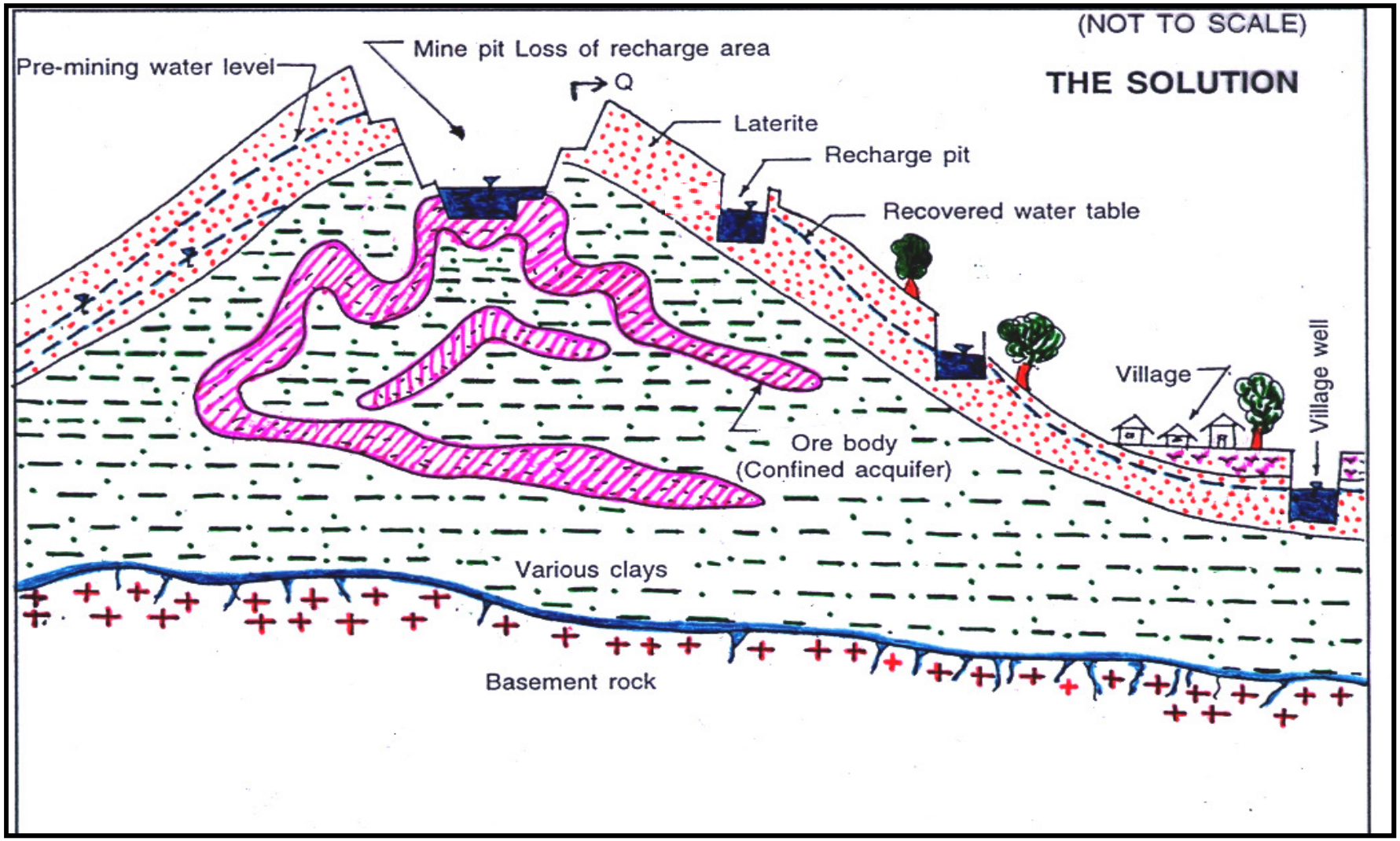
GROUND WATER CONTROL & REGULATION

PARTICULARS	NORTH GOA	SOUTH GOA
(1) Number of Over Exploited (OE) Blocks	NIL	NIL
(2) Number of Critical Blocks	NIL	NIL
(3) Number of Notified Blocks	NIL	NIL

Major Ground Water Problems

NORTH GOA	SOUTH GOA
1. Ground water in dug wells & borewells in areas around Baga & along Chapora river is brackish to saline due to seawater ingress.	1. Scarcity of ground water is observed during summer months as a result of high sub – surface and surface run off due to hilly topography and highly permeable nature of phreatic aquifer system. This results in lowering of water levels or drying of wells in some areas in summer months.
2. Ground water in areas adjacent to stream course in NE of Panjim is polluted due to domestic sewage.	2. Seawater ingress: Water table aquifers around Marmugao, especially locations close to and in the vicinity of creeks shows high electrical conductivity & chloride indicating brackish to saline nature of ground water.
3. Scarcity of ground water during summer months due to high sub – surface run off in hilly topography and highly permeable nature of phreatic aquifer. This results in lowering of water level or drying of wells during summer months.	3. In areas confined to the vicinity of creeks of Sal River, ground water is brackish and unsuitable for drinking. Salinity is more pronounced during May when fresh water flow is minimum and maximum seawater ingress takes place.

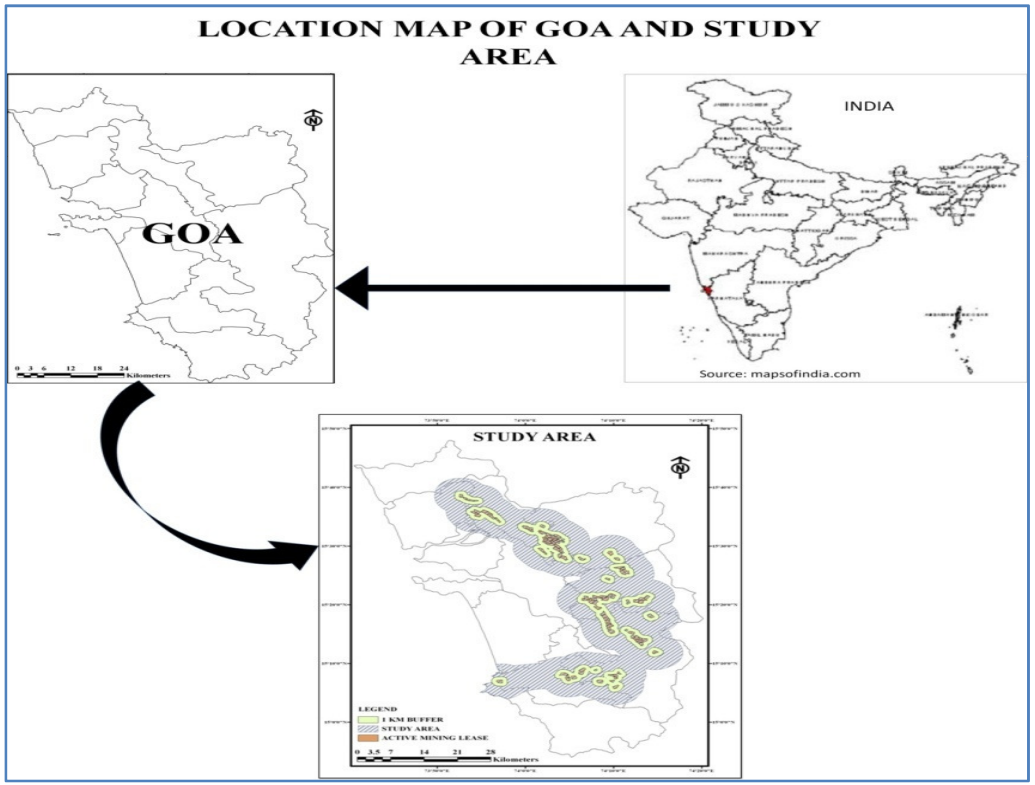
HYPOTHETICAL CROSS SECTION OF MINING AREA IN GOA



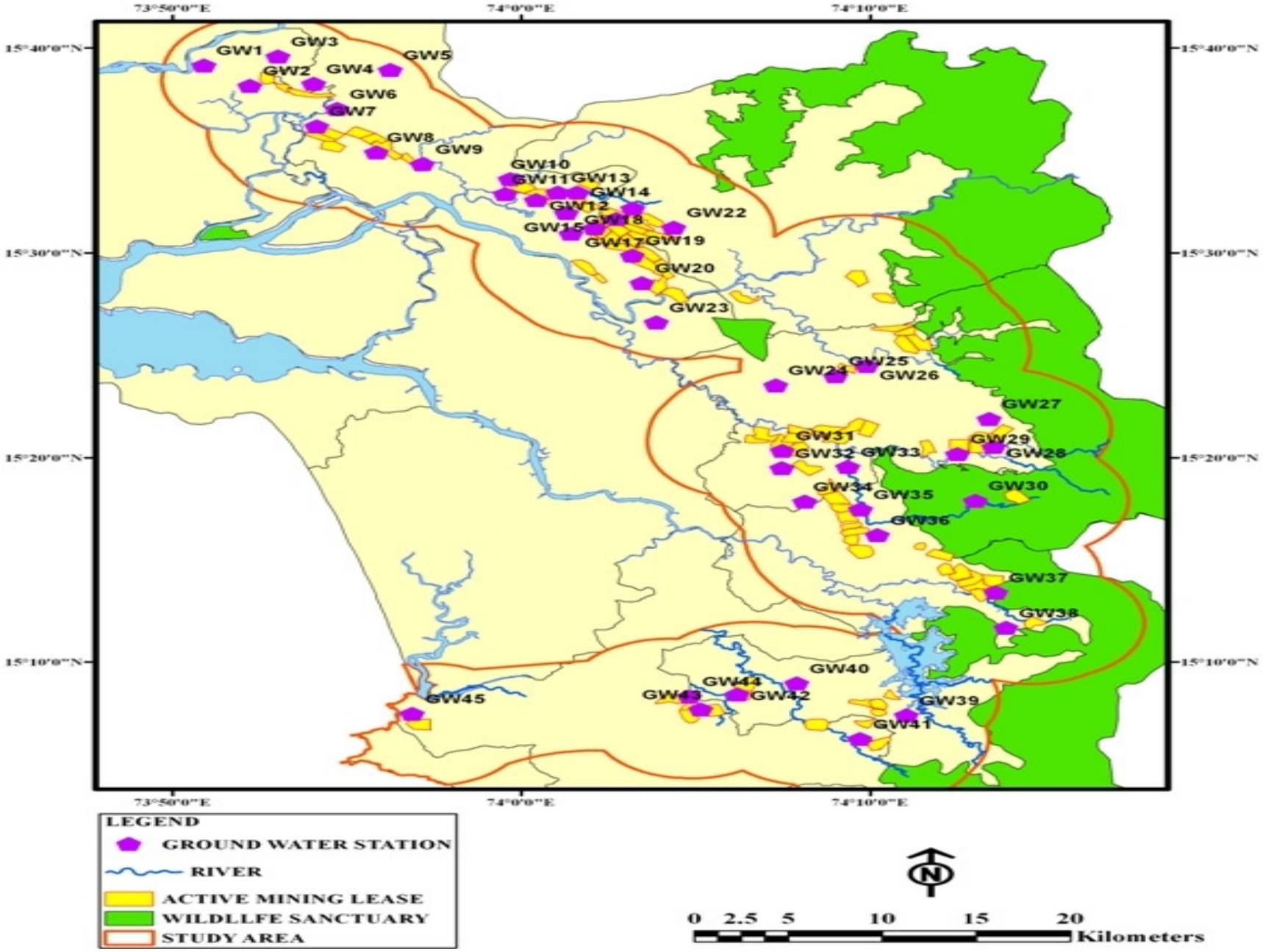
STUDY AREA

❖The study area comprises of 5 mining Talukas namely Bicholim, Sattari, Dharbandora, Quepem and Sanguem encompassing an area of 1513 km^2.

❖Study area entails all the areas wherein mining activities of Goa are encompassed along with a belt of five km from the lease boundary



GROUND WATER MONITORING STATIONS IN STUDY AREA



SAMPLING LOCATIONS

❖The water samples were collected from forty five (45) different open and tube wells during Post-monsoon, winter, summer and monsoon seasons

❖The Ground water samples were collected in acid washed plastic container to avoid unpredictable changes in charecteristics as per American Public Health Association (APHA), 2005

Water Quality Index

❖Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues.

❖The WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIS), and Indian Council for Medical Research (ICMR).The weighted Arithmetic index method (Brown et. al.) has been used for the calculation of WQI of the water body.

The overall water quality index was calculated by aggregating the quality rating with the unit weight linearly:

$$WQI = \sum q_n W_n / \sum W_n$$

$$q_n = 100(V_n - V_{io})/(S_n - V_{io})$$

q_n= Quality rating for the n^{th} water quality parameter

V_n= Estimated value of the n^{th} parameter at a given sampling station

S_n= Standard permissible value of the n^{th} parameter

V_{io}= Ideal value of n^{th} parameter in pure water. (i.e., 0 for all other parameter except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/l respectively)

$$W_n = K/S_n$$

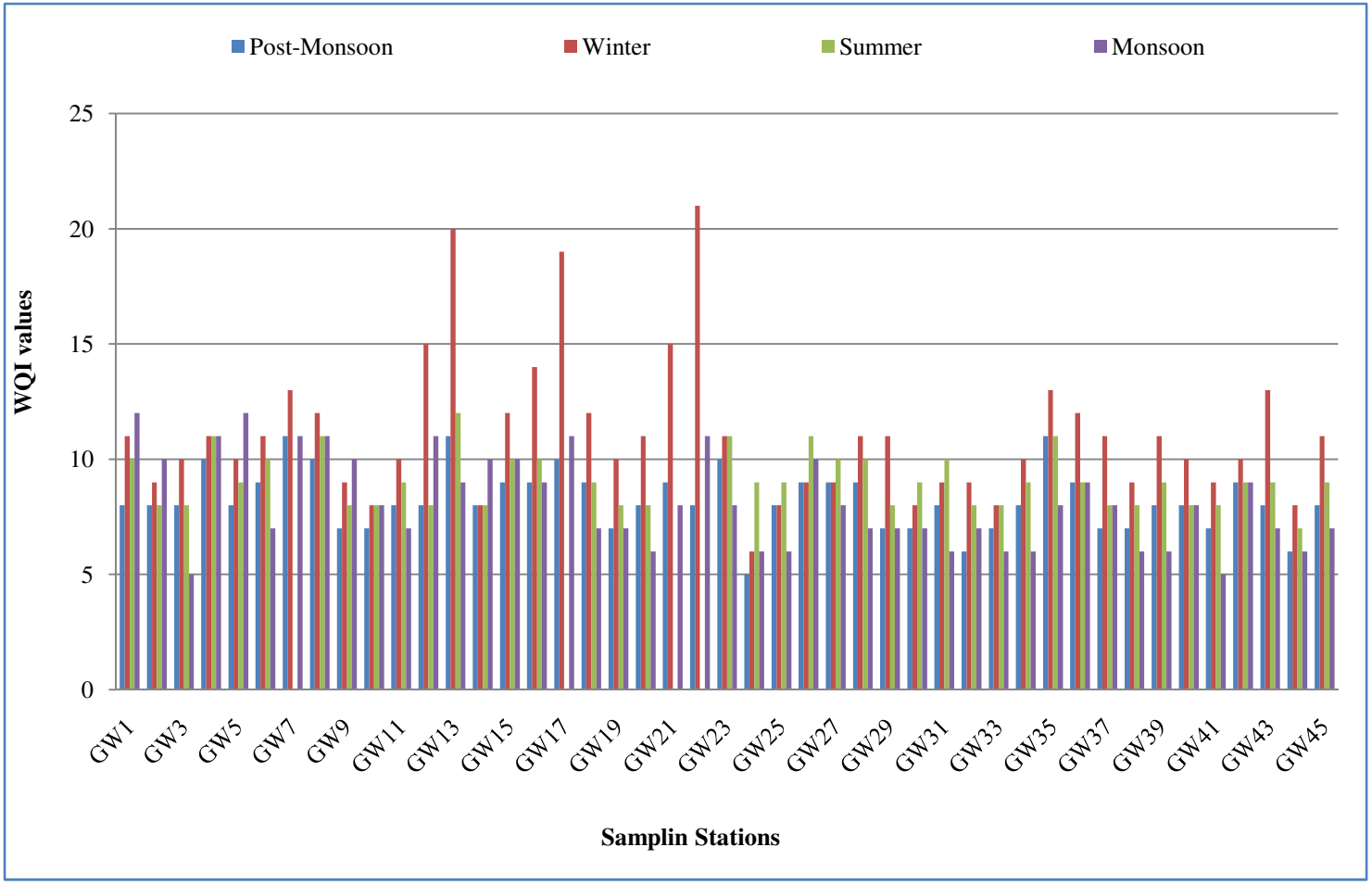
W_n= Unit weight for the n^{th} parameters,
S_n= Standard value for n^{th} parameters,
K = Constant for proportionality

WATER QUALITY RATING

Water Quality Index Level	Water Quality Status
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Moderate Water Quality
76-100	Poor Water Quality
>100	Unsuitable for Drinking

(Source: Rao 1997; Mishra and Patel 2001; Rao *et al.* 2002; Mahanta *et al.* 2004)

RESULT AND DISCUSSION



Seasonal Variation in Water Quality of Ground Water

❖On the basis of descriptive categories of WQI values, all (100%) of samples were found in very good category. During post monsoon season, 98% of samples were found in very good category and only 2% of samples in good category.

❖ In the case of post-monsoon the water quality was lower as compare to monsoon season.

❖In summer season, the ground water is stagnant and the source of contamination was only the natural source ofrock-water interaction while anthropogenic activities arealso contributing the pollution load on ground water.

CONCLUSION

❖The above study indicates that natural (ground water influenced by local litho logy, weathering moving and percolating) as well as anthropogenic sources are contaminating the groundwater in study area.

❖The study reveals that the groundwater of a few locations needs some degree of treatment before consumption and it also needs to be protected from the perils of the prevailing contamination.


THANK YOU