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Effects of Urban Activities on Underground Water of Jamshedpur

Dr. Sagar Pat Pingua (Ph.D., NET, M.A., B.Ed.)
Dept. of Geography, Faculty of Social Science
H.N.- 203, Vill.- Haludbani (Namotola), Tatanagar, Parsudih, Dist.- East Singhbhum (Jharkhand), Jamshedpur-831002, India.

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ABSTRACT

The population of Jamshedpur unban agglomeration is increasing continuously due to industrialization and urbanization. The needs of water can't be fulfill only through supply. In present, 48.11% of water-needs are depends on groundwater. Due to pressure on groundwater is decreasing rapidly. In 1960 water was available on average depth of 32.80 ft, but now their availability is doubtful also at the average depth of 360 ft. High capacity machinery are being used by the rich people for water, while hand-pumps and wells are drying up which is used by the common people. This issue also proved that:- (1) Groundwater budget is not satisfactory; because water recharge and consumption ratio is so differs, and (2) Citizens are spending lots of money and working hard for avail water. Therefore it is observed that, environment and land structure is decreasing through downfall of water table. Now it's time to take an effective action to saving water, if not we are responsible to a big mistake possibly. The presented research paper is try to show the problems, which are arise to excess use of groundwater from 1960 to 2015.

Keywords:- Factors of affecting groundwater, Groundwater quality index, Groundwater availability, Status of equipments of exploitation, Water problems in Jamshedpur.

INTRODUCTION

The quality and quantity of groundwater sources are totally dependents on their route, soil, internal land structure, nearest surfacewater quality, vegetation, man-made environment and cultural activities. In the Function of water transportation, water is Involve in transportation, distillation, absorption, reaction, weathering, dissolution and deposition etc. along with touched elements in hydrosphere and biosphere. All these factors are affected the water quality. The major source of water is rain water, Subarnarekha-Kharkai River, Sitarampur Dam and Dimna Lake. Dissolved harmful particles of surfacewater (defect of colour, taste, micro-organism, liquid minerals and chemical etc.) can reach up to 49.21 - 111.54 ft (15–34 m) depth; it can also reach to nearby wells and natural fountains. [1]

Groundwater is extruded through boring of the rocks. The region is formed by archaic laminate rocks (igneous) of Dharma range, now which is found in metamorphic form. The types of rocks are similar of schistos. The major rock type of the area is mica schist, schist, phyllite and quartzite of singhbhum group. Dharwad rocks are major source of metallic and non-metallic minerals. For example iron ore, copper, kainite, chromite and uranium etc. Internal structure is made of hard rocks. Northern area is hilly is spread from north to south-east of formed of third century rocks. Dalma range is volcanic consisting of tuffs, hornblende schists, carbon phyllite, quartzite etc. Eastern area is underlain by Tertiary formations consisting of gravel, Pebbles and Sands. It is affected by erosion, weathering.

This is region of red soil and it is formed of Archian period rocks. It is affected by soil erosion. It is low fertilizer and capacity to absorb water is very poor. Magnesium, nitrogen and phosphate and humus are very low. In this soil potash quantity is very high. The colour is primarily red but sometimes it found in yellow, hoar, brown and black. In this soil aluminum and iron silicate is found. In soil nitrogen, phosphorus acid, potash, lime and magnesium are shortage. In river bank alluvial soil is found. Mention above points effect are found in groundwater (well, tubewell, deepboring and fountain). [2]

STUDY AREA

The Jamshedpur urban agglomeration lies between latitude 21°58' and 22°48' N and longitude 85°04' and 86°54'E (**Map - 1.1**) [3]. The average elevation of the city is 159 m while the range is from 128 m to 1183 m. Total geographical area of Jamshedpur is 149.225 km^2. It population is 13,39,438 which are holding in 2,57,584 houses.

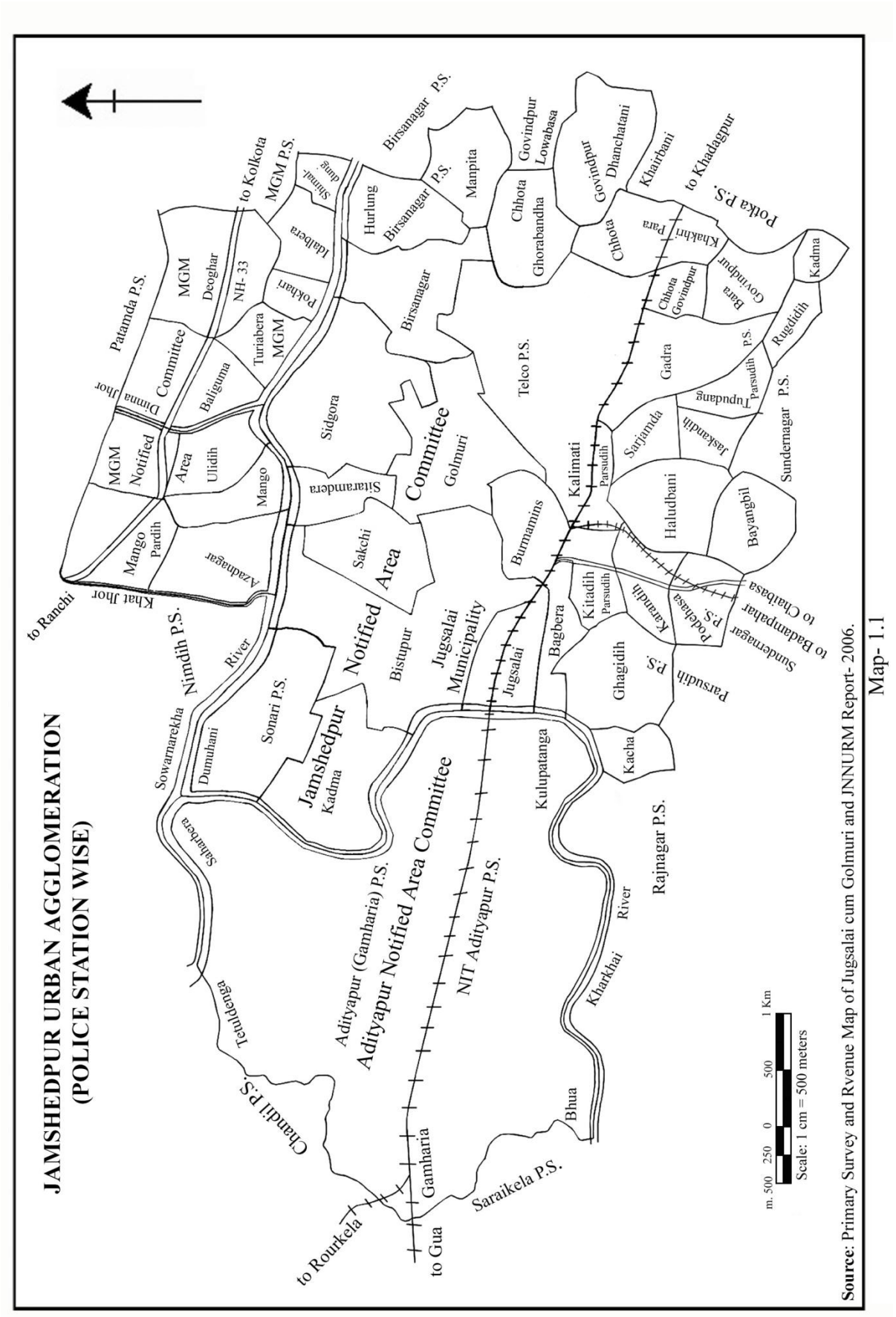
It is located at the confluence of Kharkai and Subarnarekha Rivers. Subarnarekha is flows from west to south eastern part of the territory. Kharkai flows from the south and joins the Subarnarekha at a place called Domohani. The two rivers are the major sources of drinking water and groundwater for the city.

It is a major industrial centre of East India. It houses companies like Tata Steel, Tata Motors, Tata Power, Lafarge Cement, Telcon, BOC Gases, Tata Technologies Ltd., Praxair, TCE, TCS, Timken India, Tinplate and many more. It is home to one of the largest industrial zones of India known as Adityapur Industrial Area Development Authority (AIADA) which houses more than 1,200 small and medium scale industries. Total number of industries is 1,895 and total number of leading industries 32 in Jamshedpur. These industries discharge their effluents (treated & untreated) into the ground and the river. This polluted water leaches down the soil and contaminate the groundwater. [4]

METHODOLOGY

To evaluate the nature of the groundwater in the Jamshedpur urban agglomeration, water data were collected from the wells, tubewells and deepborings at Jamshedpur Notified Area Committee, Adityapur Notified Area Committee, Mango Notified Area Committee, Jugsalai Municipality and others (Bagbera, Kitadih, Haludbani, Parsudih, Sarjamda, Gadra, Chhota Govindpur, Ghorabanda).

The data were collected in session 2011-15. Research is found the facts after collection of data from different sources. These data may be primary and secondary in nature, other resources of information from of map, charts and articles relevant to surfacewater and groundwater various also consulted. Ten percent data relating to water will be collected at seasonal basis. Finally an account based on charts and diagrams will be presented.



Source: Primary Survey and Rvenue Map of Jugsalai cum Golmuri and JNNURM Report- 2006.

Map- 1.1

REVIW

(1) According to report of 2007-08 of Central Pollution Control Board:- Groundwater is being withdrawn traditionally through the ages by dug wells in the weathered zones. The depth of water table will therefore be more in upland areas than in topographic lows. It generally varies from about 1.5 (5 ft)-16.0 m (52.50 ft) below ground level. Twenty five groundwater samples from the Jamshedpur were collected each during pre and post-monsoon seasons during the year 2006 from various abstraction sources being used for drinking purposes. The details of physical characterization of groundwater are given in **Table- 1.1** and the hydro-chemical data are given in **Table- 1.2**. [5] During pre and post-monsoon season's water quality are given in to **Table- 1.3** and **1.4** respectively. [6]

Table - 1.1: Physical characterization of groundwater in Jamshedpur (2006-07).

Norms	Pre-monsoon	Post-monsoon	More time	Avrage (Min-Max)
TSS	-	-	1,100-500	1,100-500
TDS	223-1,306	326-1210 (Maximum 2,000)	500 (68%)	32 (36)
TH	130-792 (Maximum 332.27 (May))	216-749 (Maximum 600 (8%))	Post-monsoon 300 (60%)	32 (44)
EC	348-2,040 (Maximum 1,000 (56%))	-	-	348-2,040

Source - 2008: *Status of Groundwater Quality in India -Part-II*, pp. 316-18**.**

Table- 1.2: Chemical characterization of drinking water in Jamshedpur (2006-07).

Norms	Values (mg/lts.)	Obtained	Norms	Values (mg/lts.)	Obtained
pH	6.5-8.5	5.64-7.52	SAR	-	10.4 (36.1)
BOD^{3}	-	-	Na^{+}	-	-
DO	-	-	Fe^{+++}	1000 ls de	56 (92)
Alk	0-200	60 (48)	Mn^{++}	300 ls de	56 (56)
Ca^{++}	0-75	40 (48)	Cu	0-50	88 (84)
Mg^{++}	0-30	32 (44)	Cr^{+6}	0-50	100 (100)
Cl^{-}	0-250	100 (100)	Pb	0-50	100 (92)
SO_4^{-}	0-200	92 (92)	Cd	0-10	92 (100)
NO_3 (N)	0-45	80 (100)	Zn	0-5000	100 (100)
F^{-}	0-500	96 (100)	Ar	0-50	106 (100)
K^{+}	-	0-1 (9-1)	Ni	0-1	-

Source - 2008: *Status of Groundwater Quality in India -Part-II*, pp. 316-23**.**

Table- 1.3: Seasonal Chemical characterization of drinking water in Jamshedpur (2006-07).

Norms	Pre-monsoon (mg/lts.)	Post-monsoon (mg/lts.)	More Time (mg/lts.)
pH	6.25-7.52	5.64-6.86	-
Alk	100-325	142-322	600
Ca^{++}	29-253	42-232	200 (Maximum)
Mg^{++}	14-58	18-54	75 (Maximum)
Na^{+}	11-102	13-93	-
K^{+}	0.1-4.9	0.1-9.1	-

Cl^-	15-235	24-224	250 (More Time)
SO_4^-	3-210	5-252	200 (More Time, 92%, 400 Maximum)
NO_3 (N)	0.2-442	0.4-24	More than 45, 100 is 84%, More than 100 is 16%.
F^-	0.14-1.10	0.20-0.82	1.0 (More Time)
SAR	0.39-2.8, 10.4-34.7 (Maximum)	0.38-1.95, 10.9-36.1 (Maximum)	-

Source - 1. 2008: *Status of Groundwater Quality in India -Part-II*, pp. 316-18**.** 2. 2010: Annual Report 2009-10, pp. 24.

Table- 1.4: Seasonal metallic characterization of drinking water in Jamshedpur (2006-07).

Norms	**Pre-monsoon (mg/lts.)**	**Post-monsoon (mg/lts.)**	**More Time (mg/lts.)**	**Min-Max**
Fe^{+++}	164-8056 (up to 300 is 56%)	450-53,680	-	-
Zn	184-3332	24-3140	3,000 (Pre & Post-monsoon)	-
Cu	3-145 (up to 50 is 80%)	12-111	-	-
Mn^{++}	12-1678 (100 is 12% & up to 300 is 56%)	45-1482	75 (Maximum)	-
Cd	5-12	2-6	10 (Pre & Post-monsoon)	-
Cr^{+6}	2-19	2-9	50 (Pre & Post-monsoon)	-
Pb	12-48	4-52	50 (Pre & Post-monsoon)	-
Al	-	-	-	-
As	-	-	-	100-106
Hg	2-0	1-0	-	-
Co	-	-	-	-

Source - 1. 2008: *Status of Groundwater Quality in India -Part-II*, pp. 316-18**.** 2. 2010: Annual Report 2009-10, pp. 24.

(2) According to report of 2009-10 of Central Ground Water Board:- The groundwater occurs both under unconfined condition and semi confined to confined condition. The unconfined condition exists in the weathered mantle portion of the rocks. Depth of weathered mantle varies from 15-34 m in general. The general ground water flow is towards southeast. The main potential aquifers are found in the secondary porosity developed by tectonic activities as fractures and joints. The bore wells drilled up to 150 m (492 ft) deep tapping these fractures (2 to 3 numbers) yield 12 to 20 cubic m/hrs of discharge is having 12 to 30 m of draw down.

Groundwater quality in the area is potable. All the constituents are within permissible limit of Bureau of Indian standards (BIS) except Iron and Fluoride. Fe^- concentrations in these areas are found in the range of 1-5 ppm. Kudada, Parsudih, Baghbera, Ghorabandha and Chhota Gobindpur areas have fluoride concentration in hand pump samples (1.5- 2.5 ppm). Jamshedpur urban areas like Sidgora, Karandih, Parsudih, Baghbera, Kitadih and Chhota Gobindpur are devoid of fractures so deeper aquifers do not have groundwater potential.

Long-term water level data of East Singhbhum indicate that Chakulia, Bahragora and Patamda areas are suitable for artificial recharge. In Jamshedpur urban area, Adityapur, Khasmahal, Karandih, Mango, Pardih areas are suitable for artificial recharge. [7]

(3) According to research result of 2013 of Kavita Parmar and Smriti Priya:-

(A) Physical parameters:- The appearance of samples is in general clear. They have no odour and taste. The range of temperature for the groundwater samples investigated is found to be in the range of

20°C to 25°C. Turbidity of all the samples is found to be in the range of permissible limit. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic & inorganic matter, soluble colored organic compounds and plankton and other microscopic organisms. An investigated result of physical parameters has been given in **Table- 2.1**.

(B) Chemical parameters:- The results of analyzed are given in **Table- 2.2** and are compared with water quality standards of WHO (**Table- 2.3**).

(i) pH & Electrical conductivity- The pH of the water samples are found to be in mild alkaline range of 7.5-8.2 and within the permissible range. It indicates the presence of very weak basic salts.

The ground water of three out of eight sites shows the electrical conductivity less than the permissible limit (1000 mmho/cm) whereas the six sites have the electrical conductivity beyond the permissible limit. High values suggest the presence of high amount of dissolved inorganic substances in ionized form.

(ii) Total dissolved solids- All of the sites have been found to have high concentration of TDS. The northern and southern area (Ulidih & Haludbani) has the maximum amount of solids. High level of TDS may be aesthetically unsatisfactory for bathing and washing. Water with high TDS generally is of inferior palatability and may induce an unfavorable physiological reaction in the transient consumer (Sawyernet al., 1994; Nollet, 2000).

(iii) Chloride- Chloride concentration of all the stations is found to be within the permissible limit. Chloride, in the form of chloride ions, is one of the major inorganic anions in water. The high chloride content may harm metallic pipes and structure.

(iv) Alkalinity- Alkalinity in the water samples is primarily a function of carbonate, bicarbonate and hydroxide content. All the samples show the very high alkalinity values, which are indicative of the eutrophic nature of the water. Alkanity observed, is due to carbonates and bicarbonates. Hydroxide alkalinity is absent in all the samples.

(v) Total hardness- Hardness of water as calcium carbonate is an important measure of pollution. Four sites have hardness beyond the permissible limit (500 ppm) given by WHO. Increase in the hardness is due to presence of the salts of calcium, magnesium and iron.

(vi) Sulphate- Ingestion of water containing high concentration of sulphate can have laxative effect, which is enhanced when sulphate is consumed in combination with magnesium. Sulphate contents in all the samples have been found to be within the permissible limit (200 mg/l).

(vii) Nitrates- In surface water, nitrate occurs in trace quantities but may attain high levels in some groundwaters. In excessive amounts, it contributes to the illness of infant methemoglobinemia. To prevent this disorder a limit of 45mg/l of nitrate nitrogen is imposed on drinking water. The level of nitrate in the groundwater is under the WHO limits.

(viii) Fluoride- Concentration of fluorides is significantly low in all the samples. Fluoride ions have dual significance in water supplies. Excess concentration of fluoride causes dental fluorisis. At the same time, aconcentration less than 0.8 mg/l results in dental caries.

(ix) DO & BOD- Due to physical, chemical & biological activities in water, the level of dissolved oxygen may vary. All the sites have been found to have less than 4.0mg/l DO. The lower values of BOD illustrate that there is no organic matter in the groundwater.

(x) Water quality index- A water quality index (WQI) may be defined as a reflecting the composite influence of the overall quality of a number of water quality parameters.

In the formulation of WQI, the importance of various parameters depends on the intended use of water. Since the aim is to calculate the WQI from the point of view of drinking purpose, the standards recommended for drinking water have been considered; the recommended limit is 100. WQI of all the eight sites have been found to be below 100. This data has been presented in **Diagram-2.1**. Therefore, it can be said that the quality of groundwater is satisfactory for drinking purposes. [8]

Table- 2.1: Physical characterization of groundwater.

Station	Area	Colour	Odour	Taste	Temperature(° C)	Turbidity (NTU)
1	Ulidih(North)	Colourless	Unobjectionable	Agreeable	21.4	1.66
2	Kapali (North)				20.6	1.22
3	Haludbani(South)				20.2	3.16
4	Bagbera (South)				20.4	2.25
5	Aadityapur(East)				24.3	3.43
6	Ghorabandha(East)				21	1.69
7	Baridih(West)				20	2.54
8	Govindpur(West)				22.5	2.48

Source- 2013: *Evaluation of Ground water Quality of Jamshedpur City in Jharkhand*, pp. 84.

Table- 2.2: Chemical characterization of drinking water.

Station	pH	EC (µmhos/cm)	TDS	Cl^-	Alk	TH	So_4^-	NO_2^-	F^-	DO^-	BOD
1	7.88	1900	250	0	170.19	520	470	94 8	0.38	1.6	0.6
2	7.69	1920	1150	99.27	410	480	104	7	0.53	1.8	1.7
3	7.82	1820	1850	177.28	570	1020	69	32	0.61	2	0.78
4	7.64	1290	790	60.27	260	450	64	12	0.4	1.8	2.1
5	8.23	870	800	70.91	370	500	73	15	0.44	1.9	1.1
6	7.6	1290	650	109.91	380	650	96	14	0.39	1.6	1.5
7	8.02	890	1000	74.45	260	370	70	10	0.4	1.7	0.76
8	8.25	790	650	46.09	285	700	85	19	0.4	2.1	1.7
Min-Max	7.6-8.25	790-1920	250-1800	46.09-177.28	260-520	370-1020	64-104	7-32	0.3-0.61	1.6-2.1	0.6-2.1

Source- 2013: *Evaluation of Ground water Quality of Jamshedpur City in Jharkhand*, pp. 84.
*All values expect pH and Electrical conductivity are expressed in mg/l.

Table- 2.3: WHO standards for drinking water.

S.No.	Parameter	WHO Standards
1	Colour	Acceptable
2	Odour	Unobjectionable
3	Taste	Agreeable
4	Turbidity	5NTU
5	pH	7-8.5
6	Electrical conductivity	1000 μmhos/cm
7	Total Dissolved Solids	500
8	Chloride	250
9	Alkalinity	120
10	Hardness	300
11	Sulphate	200
12	Nitrate	45
13	Fluoride	1
14.	Dissolved Oxygen	5
15	BOD	3

Source- 2013: *Evaluation of Ground water Quality of Jamshedpur City in Jharkhand*, pp. 85.

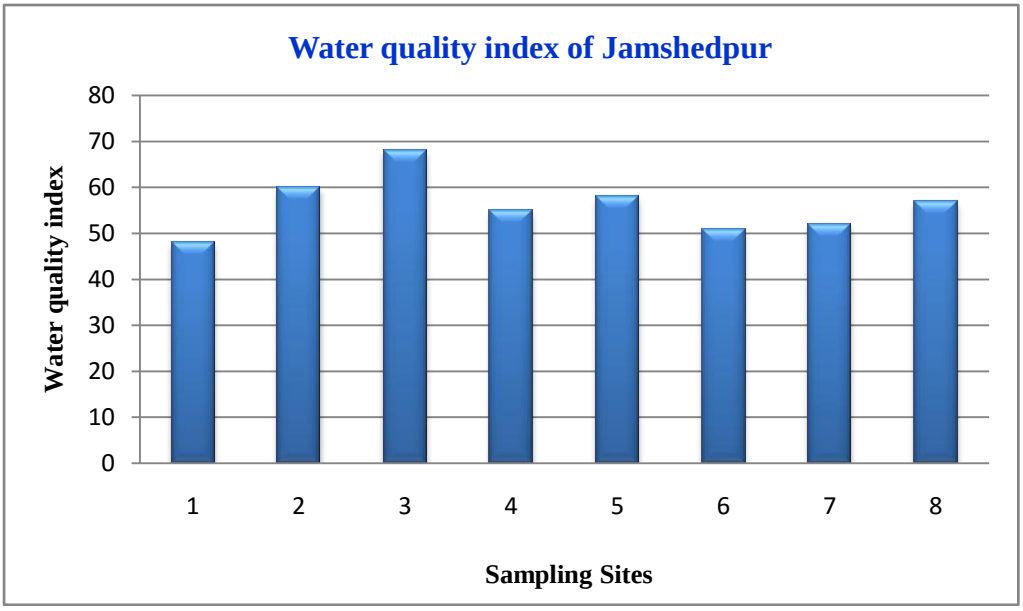
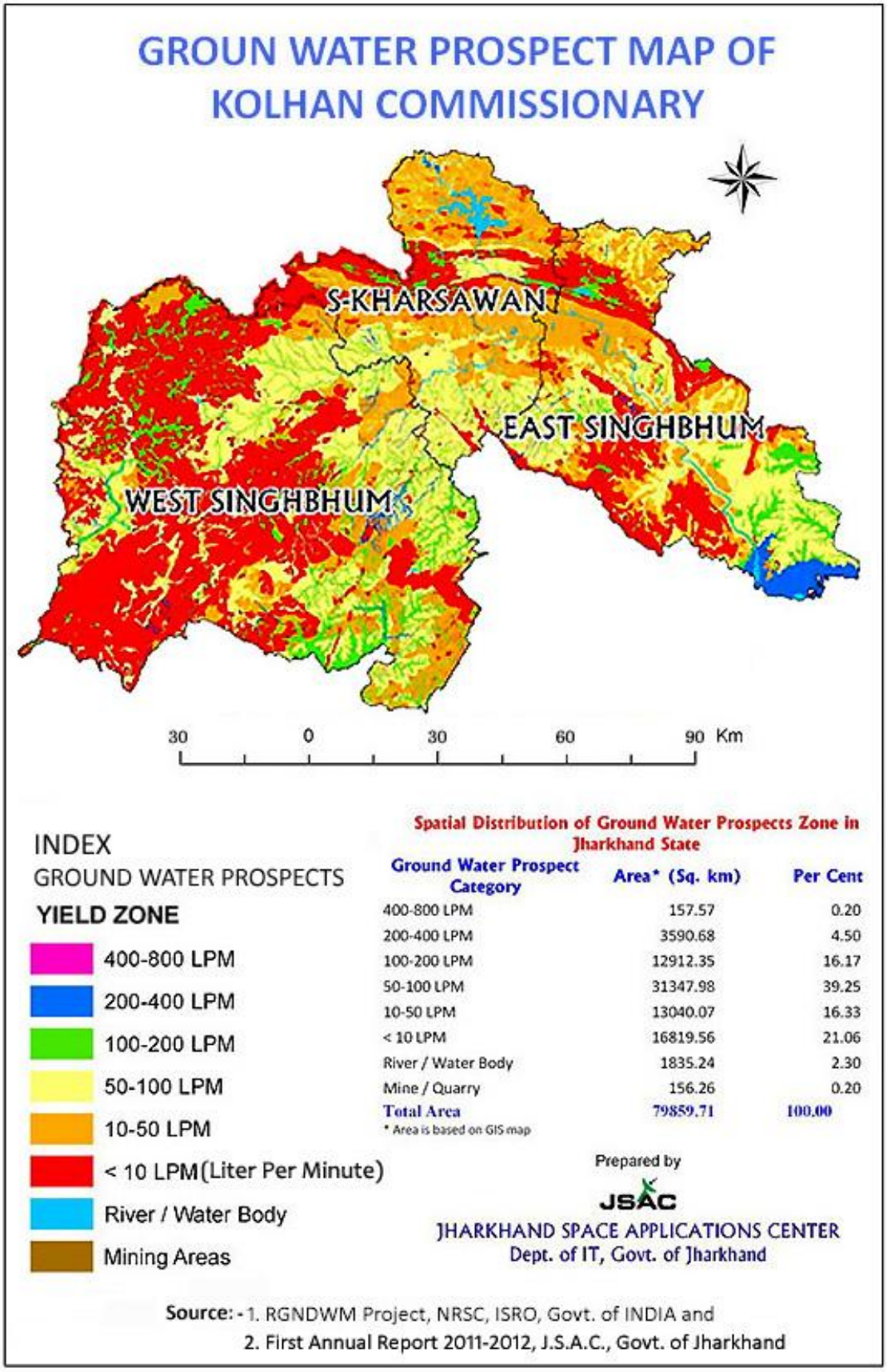


Diagram- 2.1: Water quality index values at various sampling sites.

(4) Prospect of groundwater of the kolhan Commissionary:- It is given in **Map- 3.1.** The vision of water crisis 85% area is under middle class region (flowing speed is 70-90 l/m), 10% area is under middle-low class region (flowing speed is 10-50 l/m) and 5% area is excess below class region (flowing speed is below to 10 l/m). [9] Amount of 131.39% of groundwater is consumed in the city. In 1960 ground water table was 32.80 ft; it goes down to 49.21 ft in 1970. In next decade of 1980, 1990, 2000, 2010 groundwater level goes down to 164.04 feet, 196.85 ft, 262.46 feet and 360.89 feet. Groundwater table shown in **Table– 3.1** and **Diagram- 3.1** from 1960 to 2015 (assume). [10]

Diagram- 3.1: Groundwater table of Jamshedpur from 1960-2015.



Map- 3.1

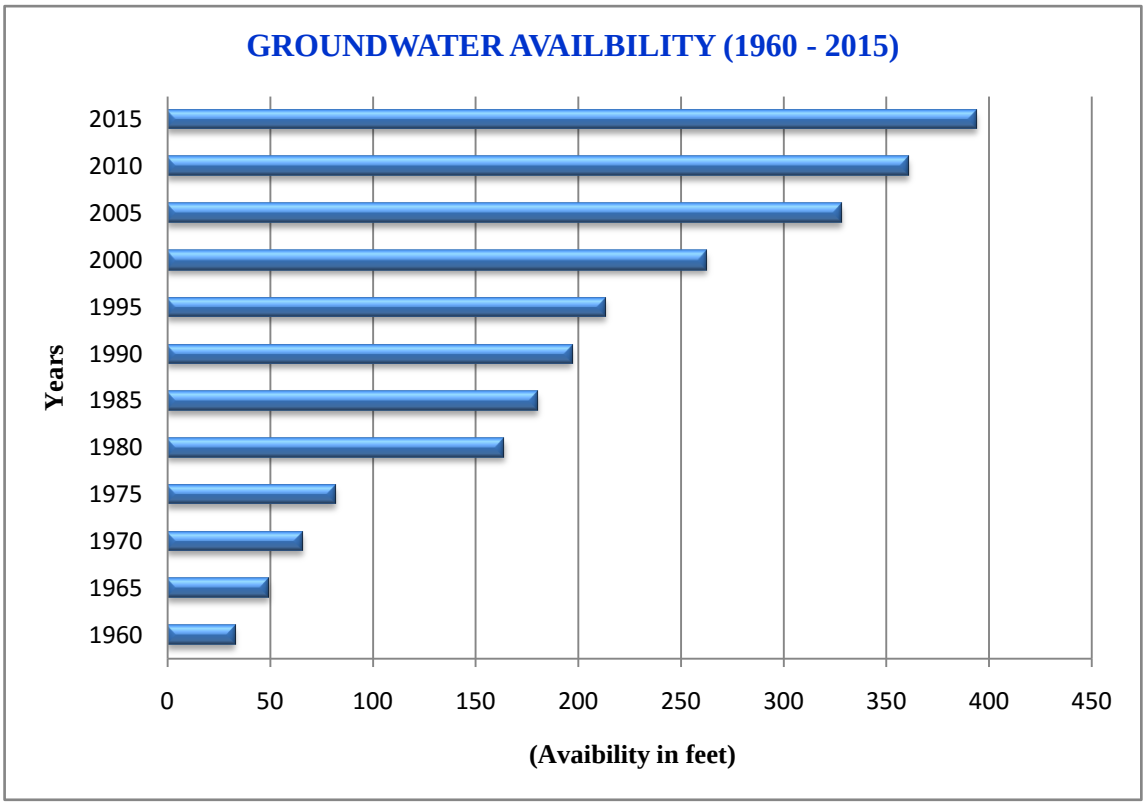


Table- 3.1: Groundwater availability (in feet):-

Years	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**
Availability	32.80	49.21	65.61	82.02	164.04	180.44	196.85	213.25	262.46	328.08	360.89	393.70 (assume)
Consumption (MLD)	31.98	37.33	42.69	53	63.31	76.35	89.39	86.345	83.30	80.31	77.32	79.11
Increment (%)	-	14.33	11.47	19.45	16.28	17.07	14.58	-3.52	-3.52	-3.58	-3.72	2.26

Source- 19.06.2014: *Halak tak nahi pahunch payega pani*, Dainik Jagran, Jamshedpur.

Status of Equipments of exploitation groundwater

Major equipments of exploitation groundwater are, 1. tubewells, 2. Deepborings and 3. Wells. Wells, tubewells and deepborings availability in numbers are respectively 2.71%, 87.79%, 11.49% but consumption of water as respectively 15.85%, 56.63% and 27.50%, **Table- 4.1** and **Diagram- 4.1** show the changes in numbers of wells, tubewells and deepborings (1991-2011), show in **Table- 4.2**, [11] consuming capacity of wells, tubewells and deepborings and **Table- 4.3**, consumption status of groundwater in town area is defected.

Table- 4.1: Consuming capacity of wells, tubewells and deepborings:-

Objectives	**Wells**	**Tubewells**	**Deepborings**
Deepness (feet)	30-50 & 50-100	100-350 &350-500	500-750 &750-1,000
Availability (%)	2.71	87.79	11.49
Consuming capacity (%)	15.85	56.63	27.50

Source- Outcome from Field survey.

Table- 4.2: Numbers of wells, tubewells and deepborings (1991-2011)

Equipments	Years	JNAC	MNAC	JM	ANAC	Others	Total	Increment (%)
Tubewells	1991	-	-	-	-	-	800	-
	2001	500	640	550	140	690	2,520	68-25
	2011	500	700	500	110	675	2,435	-3-49
	2021*	-	-	-	-	-	2,650	8-11
Deepborings	1991	-	-	-	-	-	70	-
	2001	85	5	7	45	15	157	55-41
	2011	91	19	11	77	27	223	29-59
	2021*	-	-	-	-	-	325	31-38
Wells	1991	-	-	-	-	-	70	-
	2001	21	23	18	14	33	109	35-77
	2011	17	18	15	11	27	88	-23-86
	2021*	-	-	-	-	-	75	-568

Source- 1. Field Survey and News Articles (*Prabhat Khabar* & *Dainik Jagran*). 2. 2008: *Status of Groundwater Quality in India -Part-II*, pp. 57-59. 3. 2006: *JUSCO Improving Service through Private Partnership*, Jun 2006, pp. 5. * Assumed data

Table- 4.3: Consumption status of groundwater in Jamshedpur (2011):-

Area	Depend Population	(%)	Probable Supply (lcpd)	Consumption (MLD)
JNAC	6,31,364	30	130	24.62
MNAC	2,23,805	45	110	11.07
JM	49,660	75	130	4.84
ANAC	1,74,355	55	130	12.46
Others	2,60,254	85	110	24.33
Total	**13,39,438**	**58**		**77.32**

Source- Outcome from Data analysis.

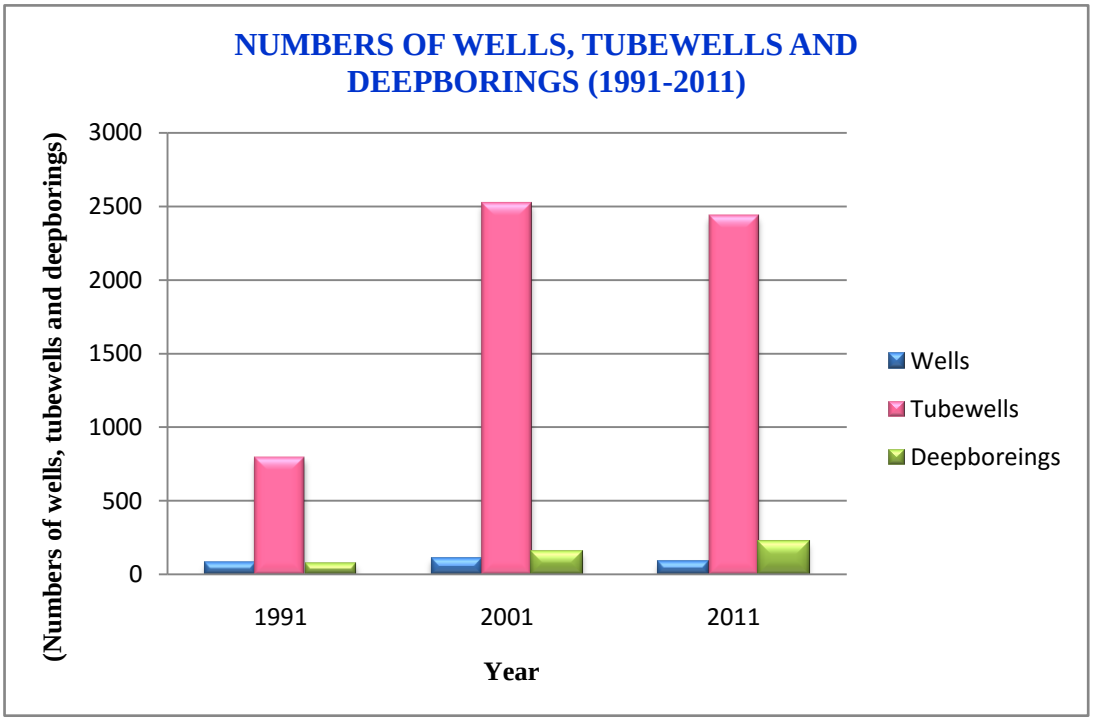


Diagram- 4.1: Numbers of equipments of exploitation groundwater in Jamshedpur from 1960-2015.

EXPERIMENTAL RESULTS AND DISCUSSION

1. Due to pressure of industrialization and urbanization on groundwater is decreasing rapidly.
2. Physical and Chemical quality and availability of drinking water is decreasing day by day. Density of micro-organisms and waste in river water is increasing day by day. It is affecting to groundwater of nearest riverbank areas (Jugsalai, Mango and Bahragora etc.). Bacteria and Germs of Malaria, Diarrhea and Chikungunya etc. is found in wells and tubewells water. Due to many people are getting die.[12]
3. Jamshedpur regions water level goes down to 6 to 10.90 meter before monsoon and after monsoon it goes down to 1.80 to 7.90 meter. [13]
4. Earthquake and land slide chances are increasing in the city. During to the installation of tubewells and deepborings are unnecessary cracks develop. Time to time, news channels and newspapers are tags to the caution for public "The internal structure of the land is being unstressed". The day is not far when the city will be upon the earth. [14]
5. The wells and tubewells are drying continuously: it may receive no water. In some places tubewells are drying like Mango, Jugsalai, Birsanagar, Baridih and others regularly since 2005. Now the day for tubewells boring is done more than 290 ft. In the news are coming regular that in some places even after digging up to 350 ft water is not found. It can state clearly that any time water crisis can be arising for the 58% population. [15]
6. Drought chances are increasing, due to fall in water table and soil moisture level is going down. Due to this biological quality of soil is also decreasing, it is getting useless.
7. Due to unavailability of water peoples are un-grating from town. Due to in some places like Mango and Prsudih people are ready to sell his goods and home. Intellectuals and capable people are doing to not consider the city, because now it is not safe for good life.
8. First time, Jawaharlal Nehru Urban Renewal Mission was tried to add the elements of groundwater along with supply system since 2006. But till now any major step have not bear in city.

SCOPE OF RESEARCH

This is a pioneer work approach in the domain of groundwater conservation and sustainable development. This work will enable us to have an account of water budget of a city region. It will also try to show the responsibility of government, industries and citizens regarding water conservation, water recharge and water management.

Main scopes of the Research are: - (a) To assess critically the problems of water resources, which generate by urbanization & industrialization. (b) To find out the challenges of water management in Jamshedpur.

CONCLUSIONS

The water quality parameters were estimated through physical study states that all drinking water quality parameters except alkalinity & hardness were found well within limit for all studied water samples prescribed by WHO.

From the results, it is evident that, the chemical parameters such as colour, taste, odour and turbidity and chemical parameters are well within suitable limits. Therefore the water from all bore suitable for drinking as per specifications.

WQI of all the eight sites have been quality of ground water of the city is satisfactory for drinking purposes.

Due to pressure of industrialization and urbanization on groundwater is decreasing rapidly. Related groundwater problems are going to serious in the Jamshedpur. For the solution, all responsibilities like water recharge, recycling, management and execution should be required for all relative people (the government, industries and citizens). There are need of efforts to water related applied research, education and low-regulation.

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Author Biography

1. **Designation:** Lecturer
2. **Name:** Dr. SAGAR PAT PINGUA
3. **Father's Name:** Harish Chandra Pingua
4. **Mother's Name:** Janki Hembrom Pingua
5. **Date of Birth:** 17 Fabruary 1985 (born in Delgapara)
6. **Permanent Address:** Vill.- Delgapara P.O.- Nayagaon Ashram, P.S.- Majhgaon, Dist.- West Singhbhum, State- Jharkhand, Pin- 833214
7. **Corresponding Address:** H.N. - 203, Vill.- Haludbani (Namotola near Vidyaniketan Public School), P.O. - Tatanagar, P.S. – Parsudih, Dist. – East Singhbhum, State- Jharkhand, City- Jamshedpur, Pin- 831002
8. **Education:**

- Ph.D. (July 2016) from Kolhan University, Chaibasa, Jharkhand – 833202.
- UGC-NET June 2011 (November 2011)
- B.Ed. (December 2007) from Karim City College, Jamshedpur- 831001
- M.A. (November 2009) from Nalanda Open University, Patna, Bihar- 800001

- Intermediate (June 2003) & B.A.(January 2006) from Lal Bahadur Shastri Memorial College, Jamshedpur- 2
- Matriculation (August 2001) from State Secondary High School, Jamshedpur- 831002

9. **Summary of Experience:**

- Dr. Pingua has done Ph.D. in the title of thesis "Impact of Industrialization on water resource of Jamshedpur urban Agglomeration" from Dept. of Geography (Faculty of Social Science), Kolhan University (along with RGNF Award of 2011-2016).
- He has engaged to M. A. and B.A. classes in Dept. of Geography, K. U. from December 2011 to December 2015 as a trainee lecturer along with involve in Ph.D.. He has also engaged Intermediate Classes from 04/11/2011 to 31/07/2012 in L. B. S. M College.
- He has an award of "Khata Sangam- 2006" for the story writing in language of Ho and Hindi from Dept. of Art, Culture, Sport and Youth Work, Govt. of Jharkhand. He has published also many article and story in magazine of "Kolhan Sakam" at Jamshedpur. Till now he has published 5 Research Paper in national & international journals and attempt 5 national seminar of UGC sponsored.

10. **Current activities:**
    He is involving to lectureship in geography and research activities.
11. **The principles of life:**
    "Only one use of life is to keep on working. If you have truth and love life also, you can achieve your goal absolutely."